INDIAN TEA ASSOCIATION

SCIENTIFIC DEPARTMENT

TOCKLAI EXPERIMENTAL STATION

ANNUAL REPORT—1955

COMMONWEALTH MYCOLOGICAL INSTITUTE
28 JAN 1957

INDIAN TEA ASSOCIATION

SCIENTIFIC DEPARTMENT

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ANNUAL REPORT FOR 1955

DIRECTOR'S REPORT

Staff.—Dr. R. J. McIlroy retired from the Directorship of the Scientific Department on 11th July, 1955. Mr. H. Ferguson was appointed as the new Director and took up his appointment on 2nd October. Dr. W. Wight acted as Director during the interim period.

Dr. D. N. Barua was promoted to the post of Plant Physiologist on 1st January, 1955, and Mr. K. C. Sarma was promoted to the post of Mycologist in the Additional Officer grade on 1st May, 1955. The following officers were appointed in 1955, all in the Additional Officer grade—Mr. D. N. Borbora as Maintenance Engineer on 1st January, Mr. S. K. Basu as Assistant Agriculturist on 28th February, and Dr. P. C. Sharma as Assistant Advisory Officer on 15th June. Dr. Sharma remained at Tocklai for training during the rest of 1955.

The following officers had normal overseas leave in 1955: Mr. A. D. Swan, Mr. D. J. Wood and Dr. G. M. Das. Mr. M. J. Green, who had gone on sick leave in 1954 returned fit and well on 3rd April.

The Senior Staff at 31st December, 1955 is listed below under the Branches concerned:

Directorate :

Director	... ...	H. Ferguson,
Personal Assistant to Director	...	J. H. Blair,
Maintenance Engineer	...	D. N. Borbora.

Physico-Chemical Branch :

Senior Physical Chemist	...	N. G. Gokhale.

Botanical Branch :

Senior Botanist	... ...	W. Wight,
Botanist	... ...	M. J. Green,
Plant Physiologist	... ...	D N. Barua.

Agricultural Branch :

Senior Agriculturist	...	S. K. Dutta,
Assistant Agriculturist	...	S. K. Basu.

Plant Pathology Branch :

Senior Entomologist	...	G. M. Das,
Mycologist ...	...	K. C. Sarmah.

Biochemical Branch :

Senior Biochemist ...	...	D. J. Wood,
Biochemist ...	...	N. B. Chanda.

Engineering Development Branch :

Senior Research Engineer	...	I. McTear,
Research Engineer ...	...	Vacant

Assam Advisory Branch :

Senior Advisory Officer, Assam	P. M. Glover,
Advisory Officer, Cachar ...	E. D. Heath,
Assistant Advisory Officer, Assam	P. C. Sharma.

West Bengal Advisory Branch :

Senior Advisory Officer, West Bengal (Dooars)	...	R. I. Macalpine,
Advisory Officer, Darjeeling & Terai ...	...	A. D. Swan.

Visitors : The following members of the Indian Tea Association visited the Station :—

Mr. H. C. Bannerman, Chairman of the Indian Tea Association, London, on 9th December ; Mr. G. A. Rainey, Member of the Indian Tea Association, London, and Deputy Chairman of the London Advisory Committee, from 16th to 17th November ; The Chairman, Mr. C. D. Wilson, and Mr. E. H. Adams of the Scientific Sub-Com-

mittee, Indian Tea Association, Calcutta, from 22nd—24th August; Mr. H. J. Walsh, Additional Adviser, Calcutta, from 22nd—24th December.

Other visitors to the Station included:—

Mr. D. W. Tull, Engineering Consultant to the Indian Tea Association, London from 14th to 26th November; Dr. William J. Ellis, Head of U.N.E.S.C.O. for South East Asia on 12th October; Mr. R. D. Thompson, the American Agent for Messrs. Finlays, on 29th August; Mr. H. Farwardin, Tea Department, Government of Iran studied in Tocklai under the auspices of F.A.O. from 14th April to 11th July; Mr. Yasumato and Mr. Suzuki, business men from Japan on 12th December, and a party of Cottage Industry experts from Japan on 14th November. Dr. J. N. Mukherjee, Dr. J. C. Sen Gupta, Dr. B C. Guha and Mr. P. K. Barua of the Tea Board *Ad Hoc* Committee on Tea Research visited the Station on 25th and 26th November.

Many visiting agents, superintendents, managers and tea garden assistants visited the Station to seek its services.

Touring.— Short visits were paid to tea gardens in Cachar, Darjeeling and the North Bank at the time of the Indian Tea Association Branch Meetings in these areas.

Meetings.— The Director attended the following meetings:—

Surma Valley Branch Annual General Meeting, Silchar on 2nd February; Assam Branch Indian Tea Association, Jorhat on 12th February; Darjeeling Branch Indian Tea Association on 12th March. Calcutta Indian Tea Association Annual General Meeting on 18th March; Scientific Department Sub-Committee Meeting on 18th March. Engledow Commission Sub-Committee on 18th March; The Dooars Branch Indian Tea Association on 10th February was attended by Mr. S. K. Dutta and Mr. R. I. Macalpine representing the Director; Assam Branch Indian Tea Association Meeting at Thakurbari on the 18th and 19th November; Scientific Department Sub-Committee

Meeting on 7th December; Tea Board *Ad Hoc* Committee on Scientific Research on 8th December.

Conference.— It was not possible to hold the Tocklai 12th Annual Conference during the 1955 calendar year, but it was held instead on the 20th, 21st and 22nd February, 1956. The subjects chosen for discussion were *Manuring, Replanting, Vegetative Propagation, Engineering Development* and *Tea Tasting.* Set addresses were given on each of these subjects and, in addition, questions set by delegates on other aspects of tea production were discussed. Delegates to the Conference represented the Calcutta Scientific Sub-Committee and the Indian Tea Association Branches. In addition to the delegates, Mr. de Jong, Chief Scientific Officer, United Planters' Association of Southern India, Dr. Abbasi, Chief Scientific Officer of the Pakistan Tea Board, Mr. D. L. Downie of Mimosa Tea Research Station, Nyasaland, and a limited number of local visitors attended by invitation.

Courses.— Three Lecture Courses for planters were held between February 14th and March 4th and were attended by 81 planters. Each Course was of 4 days duration.

Two Courses on Vegetative Propagation were held from May 2nd to 5th and 9th to 12th. These Courses were attended by 40 planters.

Publications.— The following Tea Encyclopaedia Serials, Journals and articles were published during the year:—

Tea Encyclopaedia Serials :

70/1 Control of Primary Root Diseases of Tea (Revision).

71/1 Red Spider (Part II) (Revision).

77/1 Control of Termite Attacking Live Wood of Tea (Revision).

86/1 Proprietory Insecticides, Fungicides, Selective Weed Killers and Preservatives (Revision).

93/1 Organisation of Spraying (Revision).

106 *Helopeltis Theivora* Waterh. (Tea Helopeltis).

107 How to send Soil Samples from Proposed Nursery Sites.

108 Tea Seed Nurseries.

109 Rim Blight or Marginal Necrosis.

Journals :

"Two and A Bud" (Tocklai Newsletter) Vol. II Nos. 1, 2, 3 & 4.

Articles :

Science in the Tea Industry, by R. J. McIlroy—Tea Trade and Industry, June, 1955.

The Nature of Dormancy in the Tea Plant, by W. Wight, and D. N. Barua—J. Expt. Bot. February, 1955.

Dormancy in Relation to Plucking and Pruning of the Tea Plant, by W. Wight—Phytomorphology, March, 1955.

Selection and Seed Production Policy in Assam, by W. Wight—J. Tea Research Institute of Ceylon, March/June, 1955.

Pretreatment of Tea Cuttings for Distribution by Mail, by W. Wight and P. K. Barua—J. Hort. Science, April, 1955.

Longevity of the Tea Plant and the Rational Use of Tea Garden Land, by W. Wight and N. G. Gokhale—The Commercial Times (India), May, 1955.

Commercial Propagation of *Camellia sinensis* in India, by W. Wight—American Camellia Year Book 1955.

Estimating the Decrease in Yield on Ceasing to Manure Unshaded Tea, by N. G. Gokhale—Emp. J. Exptl. Agric., April, 1955.

On Formulating Manuring Policies for Tea, by N. G. Gokhale—Tea Trade and Industry, September, 1955.

Reduced Light Intensity and Nitrogenous Manures—(Effect on the Cup Characters of Made Teas), by S. K. Dutta and S. Basu—Tea Trade and Industry, July, 1955.

Tea Cultivation in N. E. India, by S. K. Dutta—Planters Journal and Agriculturist, August, 1955.

The Chemical Composition of Tea, by R. J. McIlroy—Food, June, 1955.

Allergy by S. K. Sen,—Indian Medical Journal, April, 1955.

Theogallin as a Galloyl Ester of Quinic Acid, by R. A. Cartwright and E. A. H. Roberts Chemistry and Industry, 1955.

The Conformation of the Epimers of Catechin and Gallocatechin, by E. A. H. Roberts—Chemistry and Industry, 1955.

The Suspected Presence of p-Coumaryl-quinic acids in Tea, Apple and Pear, by R. A. Cartwright, E. A. H. Roberts, A. E. Flood & A. H. Williams—Chemistry & Industry, 1955.

Conformation of Catechins and Gallocatechins, by E. A. H. Roberts—Chemistry and Industry, 1955.

Labour Relations.— Relations with employees and labour remained good throughout the year.

Medical.— The health of the staff was good during the year.

The construction of the new Borbhetta Dispensary in 1955 has proved of great value and has greatly facilitated work of the staff at Borbhetta. Every laboratory at Tocklai and the main office at Borbhetta are provided with first aid boxes.

During the year 14,441 cases were treated representing a great variety of diseases. The most common of these are mentioned below.

Amongst the more common skin diseases were pemphigus, impetigo, scabies, contact dermatitis, allergy dermatitis, abscesses and boils. Of the various eye diseases ophthalmis, stye, corneal ulcer and blepharitis, were prominent. The various ear diseases were generally due to infection of the external and middle ear with pathogenic organisms. Epistaxis, ozoena and catarrhal rhinitis were common nasal troubles. The infections of pharynx, larynx and tonsils of benign type were frequent. Incidence of influenza and bronchitis was high. Asthma, pneumonia, pleurisy and tuberculosis of lungs were also found in different degrees. There were incidences both of bacillary and amoebic dysentery Gall bladder and liver diseases with jaundice, gastritis, hyperchlorhydria, gastric and duodenal ulcers, enteritis, colitis, piles and appendicitis occurred. Amongst worm infection roundworm and hookworm were the major problems. Amongst the infectious diseases, diphtheria, mumps, measles, chicken pox and whooping cough occurred. Other important diseases which required treatment occasionally were, anaemia, nephritis, rheumatism, hypertensive disorders, food poisoning, sciatica, epilepsy, goitre, neuralgia and infantile convulsion. There were also cases of accidental injuries and entrance of foreign body into the eye, generally amongst the workshop workers. Only one case required antirabic treatment during 1955. Tetanus as a consequence of cuts and wounds was avoided by giving timely prophylactic injections with antitetanic serum.

The incidences of typical deficiency diseases were extremely rare, only a few cases of rickets and night blindness were found amongst the labour children.

The anti-malaria work at Tocklai and Borbhetta is keeping the staff practically free from malaria, whereas there were previous records of death due to cerebral malaria and black water fever. By taking proper measures against preventable diseases, malaria, small-pox, tetanus, cholera and typhoid have been rare.

The anti-malaria research work continued on the basis of searching and collecting *Anopheline* larvae from the breeding sources of control areas and the various species were further identified under the microscope in the laboratory. The following types of larvae were found to be very common in all the Anopheline breeding sources:—

A. aconitus, A. hyrcanus, A. phillippinensis, A. vaguss, A. barbirostris, A. kochi.

A. minimus appears to show discrimination in the selection of breeding grounds. By constant and careful observation knowledge of their breeding habits in neighbouring drains and nullahs has been definitely ascertained. Wherever *A. minimus* breeding areas were found, they were sprayed thoroughly with malariol and a mark in the control board was kept to continue to make the areas unsuitable for future selection by *A. minimus* for breeding. All other areas producing different types of mosquitoes remained unsprayed in order to economise on malariol. The excess in general mosquito population in the Station was kept down by spraying with Gammaxane at regular intervals. The result of anti-malaria work for the year 1955 was excellent.

A sample latrine seat with a water seal to prevent fly and mosquito breeding is being tried out, and will not be more costly than the orthodox type. This type of seat is to be adopted for Station bore-hole latrines.

One article on Allergy was accepted by the Scientific Committee of the Indian Medical Journal and was published in the month of April, 1955.

Building and Maintenance :

Staff —The Maintenance Engineer assumed his duties on the 1st January, 1955. One Maintenance Assistant was appointed at the beginning of the year.

Review of work done in 1955.—General maintenance of the station roads and buildings was carried out throughout the year. The following work was taken up and completed during the year ending 31st December 1955.

Roads.—One reinforced concrete bridge was constructed over the main nalla on the road leading to the Personal Assistant's Bungalow. Construction of the road leading to Borbhetta Bungalow sites was made.

Water Supply.—A 3 inch tube well to depth of 350 ft. was bored, to augment Tocklai water supply during dry season and a compressor for air lift pumping of the water was installed. An earth tank was excavated at the Borbhetta building site to constitute the main source of water supply for Borbhetta Bungalows.

Buildings.—Pent roofs on top of the following flat roofed buildings were constructed:—(1) Guest House, (2) Bungalow No. 4, (3) Bungalow No. 5. Bungalow No. 2 at Tocklai was dismantled in 1954 and a new bungalow on the same site was built in 1955. An extension to the Soils Laboratory was built during the year and furniture and fittings installed. The Withering House of the Experimental Factory was completely re-built and fitted with equipment for speeding up the process of withering. Floors in the Guest House were re-laid and interior decoration work done during the year under review. Asbestos building board ceiling was fitted in the Agricultural Laboratory. A domestic hot water system was installed in Bungalow No. 1 at Tocklai during the year. Two Bungalows at Borbhetta were constructed during the year. No. 1 is now occupied and No. 2 will be ready for occupation early in 1956. A pump and power house for Borbhetta Bungalows was constructed and generator sets installed there.

Experimental Factory.—Machinery in the rolling room was re-arranged during the year and the drives from the line shaft and D.C. motors were changed to independent A.C. motor drive, to secure the desired flexibility of operation for experimentation. One Humidifying Chamber was constructed to allow moist air to be blown into the Rolling Room. Two air-conditioning units were installed in the Biochemical Laboratory in a small room, the walls and ceilings of which are insulated by fibre boards.

Telephone.—An internal telephone system was installed in Tocklai connecting the Offices and Laboratories.

Research and Experiment :

Detailed reports from each branch or section at Tocklai follow, so that only a brief summary of research work is required here.

Physical Chemistry and Meteorology.—Progress has been made with the study of the exchangeable properties of tea soils when subjected to varying fertiliser treatments. Continuous use of sulphate of ammonia over a long period brings about an appreciable diminution of the base status of the soil. Calcium economy has also been studied, and under the conditions pertaining in tea soils, its depletion is much slower than expected. Studies on aluminium, on anion exchange, on seasonal variations of pH and on phosphate availability under shade, have also been made on tea soils. In addition to the recording of the usual meteorological observations, certain micro-climate studies have been carried out.

Botany.—Work on the classification of tea plant populations has continued and, in connection with this, work on the systematics of the tea plant, and the Senior Botanist has under preparation a publication relating to these. The long term breeding programme was maintained during the season. Investigations are continuing on the mechanism of shade effects on yield. Studies on the frequency of calcium oxalate crystals in the tea plant have continued and it has been shown that injection of certain salts reduce the number of calcium oxalate crystals, and there frequency appears to be a sensitive quantitative index of metabolic change associated with nutrient uptake.

Agriculture.—The usual large programme of long term field experiments on manuring and shade, and their interactions, and on plucking and pruning methods, was continued during the year. Further interim results from these experiments were in accordance with previous findings. A number of new shade tree species are being raised for trial. These include both indigenous and exotic species. Early growth of several species has been promising.

Plant Pathology—Entomology.—Trials with new insecticide and acaricide formulations against the major pests of tea continued throughout 1955. Certain of the products tried gave limited success against Red Spider, and considerable success in controlling termites was achieved by soil application of 'Aldrin' and 'Dieldrin'. Dieldrin having a high persistent action may be successfuliy incorporated in the tea fertiliser, and this offers an easy method of application. The systematics and life history of some of the less common tea pests were studied.

Plant Pathology—Mycology.—New fungicides were tried out in field experiments against Black Rot (*Corticium invisum* and *C. theae*) and Red Rust (*Cephaleuros parasiticus*) both as control and prophylactic measures with varying results. Studies and fungicidal trials were also carried out on Nectria disease, *Sclerotinia* disease of tea flowers, and on certain primary root rots. Trials with soil fumigants to control eelworm were carried out with only limited success. As usual the identification of damaged specimens of tea and shade trees and associated advisory work took up much of the mycological sections time.

Biochemistry.—Experiments were carried out on different aspects of withering in relation to amount and rate of wither and in connection with the withering tunnel. These have produced useful factual data. Chemical changes during withering were studied in relation to environmental factors associated with the wither. Work on caffeine and on the identification and distribution of volatile substances in tea continued.

Tea Tasting.—Some 12,000 samples were tasted during the year, coming mainly from Tocklai manufacturing experiments and from clonal and manufacturing trials carried out on estates. Assessments were made of all teas made in the withering tunnel and continuous roller experiments.

Engineering Development.—1955 has seen considerable progress with mechanical plucking, mechanical pruning, controlled withering and continuous rolling. In the case of the withering tunnel a full season's trial was carried out, and has provided reliable data on the performance of the tunnel and on

the quality of tea made from it. Both the performance and the product have been satisfactory. In the case of plucking, modifications to improve selectivity were made and tried during the season, and in the case of pruning reasonably satisfactory results have been obtained using a modified roto-scythe attachment on the plucker chasis. Two radically different types of continuous roller were tried in 1955 and produced teas with fully satisfactory liquoring qualities. Modifications carried out as a result of these trials are likely to improve the appearance of the rolled tea, and bring the appearance as well as the liquor up to the required standards.

Advisory Services :

Assam Advisory Services.—The Advisory services in the Assam Valley and Cachar were widely patronised during the year. 1955 was the first year in which Cachar had a full service and the Surma Valley planters have expressed their satisfaction and appreciation of this new service. A number of new manurial and other experiments have been laid out in the Assam Valley and Cachar.

West Bengal Advisory Services.—Normal advisory services were maintained during the year in the Dooars and in Darjeeling and the Terai. Experiments on manuring and pruning in the main regions of the West Bengal tea area were continued, and observations on possible new shade trees and green crops were carried out.

PHYSICO-CHEMICAL BRANCH

N. G. Gokhale, Senior Physical Chemist

GENERAL

Advisory work and correspondence.— During the year, acidity and other routine tests were carried out on 1,355 soil and other samples received from tea gardens. In all, 279 advisory reports concerning soil problems were issued to tea gardens and, in addition, 280 other letters were written.

Visits.— The Senior Physical Chemist paid visits to 10 gardens in the Golaghat, Jorhat, Tezpur and Sonari circles and 23 gardens in central and eastern Dooars during the year.

Publications.— Gokhale, N. G., "Estimating the decrease in yield on ceasing to manure unshaded tea", *The Empire Journal of Experimental Agriculture*, 1955, *23*, 96-100.

Gokhale, N. G., "On formulating manuring policies for tea", *Tea Trade and Industry*, 1955, *4*, No. 10, 599-600.

EXPERIMENTS

Spray application of Sulphate of Ammonia.— The question as to whether fertiliser, in particular Sulphate of Ammonia, could not be sprayed on to tea bushes instead of being applied in the usual manner, has been brought up on a number of occasions. Spray application of Sulphate of Ammonia is not considered to be a practical proposition for shaded tea but, nevertheless, it was thought worth while to obtain certain preliminary information regarding the concentrations which could be safely employed for this purpose. Spraying trials were therefore carried out using solutions of Sulphate of Ammonia, the concentrations varying between 0.1 and 5.0% and the amount of solution adjusted so that the amount of nitrogen applied was at rates between 40 and 80 lb. per acre. The extent of fertiliser injury observed varied, depending on a number of factors, such as the concentration of the fertiliser solution, the occurrence (times and amounts) of rainfall after spraying, the age and condition of bushes, age of leaf etc. The broad conclusion from these trials was that, if Sulphate of Ammonia was to be sprayed on to tea bushes,

then concentrations above 1.0% could not be considered as entirely safe. It is not desired to pursue this inquiry any further but the limited information obtained is now recorded. The assistance of the mycological branch in this investigation is hereby acknowledged.

Seasonal variation of pH.— A statistically designed trial was carried out to investigate the seasonal variation of pH. A 6 × 6 latin square layout, replicated three times, was used for the experiment, and samples of the top soil (0–9″) were drawn on six occasions in 1955, at intervals of two months. The plots were allowed to grass over during the course of the year. The results obtained in the case of the three replicates are not entirely consistent but the fact that soil acidity changes during the year has been established (see table 1). The calculations have been presented in terms of both the pH and the H ion concentrations.

TABLE 1

Statistical analysis

	D.F.	Values of mean squares: pH ($\times 10^4$)	H ion concentration ($\times 10^{14}$)
Plot	2	1,795 ***	16,771 ***
Row	15	136	1.361
Column	15	186	1,839
Time	5	505 ** (Sig. $P < 0.01$)	5,154 * (Sig. $P < 0.05$)
Error	70	142	1,670

The seasonal variation in pH may be due to many causes and further work on the precise factors which are responsible, in the case of cropped and bare soils respectively, is contemplated.

Anion exchange capacity.— Attempts have been made to measure the Anion exchange capacity of representative soil samples from the different tea districts of north east India. The procedure followed was essentially that described in Piper's "Soil and Plant Analysis" but with certain modifications in respect of the methods of digestion and displacement of adsorbed phosphorus. Preliminary results are quoted in table 2 below

It may be noted that the figures are comparative and are not to be treated as absolute values.

TABLE 2

Anion Exchange Capacity

Soil sample mark		pH (water extract) of soil	Total Anion exchange capacity at pH 4, m.e./100 gm. soil
Borhat	...	3.80	36
Dwarband	...	4.41	20
Bhelaguri	...	4.54	18
Monabari	...	4.67	22
Kalaincherra	...	4.85	23
Kalchini	...	4.87	11
Budlabeta	...	4.88	14
Amluckie	...	4.95	10
Craigpark	...	5.00	14
Hansara	...	5.04	10
Sockieting	...	5.10	19
Subong	...	5.18	9
Limbuguri	...	5.70	6
Bhatpara	...	5.77	12

The values of Anion exchange capacity of the samples examined varied considerably. Further work on the correlations between Anion exchange capacity and other soil properties is in hand.

Aluminium in tea soils.—The tea plant is known to be an aluminium accumulator but whether it merely tolerates high concentrations of aluminium or whether a high availability of aluminium in the soil is an essential condition for optimum growth of tea has not yet been established. We favour the latter view but definite proof has yet to be obtained. In assessing the suitability or otherwise of an area for tea, great reliance is placed on the pH (of water and KNO_3 extracts) of the soil. We favour the view that instead of relying on pH measurements, it may be preferable to express the requisite condition for optimum growth of tea in terms of the availability of certain cations, possibly the ratios of available Al: Mn: Ca: Mg. A start has been

made in this investigation by determining the available aluminium in soils.

A colorimetric method for estimation of aluminium, which generally follows the procedure of Chenery*, has been standardised. The measurements were made on a Spekker for which a calibration chart was prepared. Determinations were made in duplicate and the tests were repeated on six days during the period 25-5-55 to 23-6-55.

TABLE 3

Calibration chart for estimation of aluminium

		Aluminium, parts per million								
		0	6	12	18	24	30	36	42	48
Spekker drum reading × 100	Mean of 12 repeats	116.8	106.2	98.9	92.5	86.1	80.1	72.9	65.2	59.2
	S. D.	0.9	0.5	0.6	0.5	0.8	0.6	0.7	0.6	0.7

Some of the results obtained for exchangeable aluminium (extractant used being 1 molar NaCl) are quoted in table 4 below.

TABLE 4

Available aluminium in tea soils

Soil mark	pH (water extract) of soil	Exchangeable aluminium (NaCl) p.p.m.
Lamabari (virgin)	6.00	Nil
Telepara ...	6.00	trace
Tyroon (Ant tilla site)	6.52	36
Kopati ...	5.50	trace
Aenakhall (flat)	5.27	66
Balijan ...	4.93	216
Gatoonga ...	4.68	240
Binnakandy (virgin)	4.60	324
Baghmari ...	4.30	288

* Chenery, E. M., "A preliminary study of aluminium and the tea bush", Plant and Soil, 1955, *6*, *No. 2*, 197-200.

Phosphate availability under shade :

Superphosphate applied for 13 years under different species of shade trees, Borbhetta area 1A.—An attempt was made to assess the phosphate status of soils which had been subjected to continuous phosphate treatment for a number of years, the areas being under different species of shade trees. Soil samples (top 9") were drawn in July 1954 from some of the plots of Borbhetta area 1A which had received only Superphosphate treatment (no other fertiliser having been applied to these plots) as per details given in table 5.

TABLE 5

Details of phosphate and shade treatments, Borbhetta area 1A*

Shade (planted (1940)	Phosphate treatment
Aleuritis montana (from 1941). Albizzia stipulata (green). ,, ,, (red). ,, odoratissima. Derris robusta. Check (under Grevillea robusta until 1944, since then without shade).	40 lb. of P_2O_5 per acre yearly from 1941 to 1954, excepting 1946 when no phosphate was applied. Total phosphate applied to these plots (until July 1954) was 520 lb. of P_2O_5 per acre.

The soil samples were examined for phosphate by the following three methods :

Method (a) Total phosphate, Magnesium Nitrate method (A.O.A.C.)

,, (b) Phosphate in HCl extract (Hall's method)

,, (c) Phosphate in 1% Citric acid extract.

(* two shade treatments not included in this investigation)

Summaries of chemical and statistical analyses are quoted in table 6.

TABLE 6

Phosphate analysis, Borbhetta area 1A

Shade	Phosphate as P (not P_2O_5), % on air dry soil, means of four replicates		
	method (a)	method (b)	method (c)
Aleuritis montana	0.0274	0.0199	0.0025
Albizzia stipulata (green)	.0329	.0228	.0026
„ „ (red)	.0280	.0240	.0033
„ odoratissima	.0290	.0220	.0026
Derris robusta	.0280	.0241	.0030
No shade (since 1944)	.0319	.0215	.0024
S. D. reqd. at P=0.05	0.0065	0.0044	0.0011

None of the above differences are statistically significant. The hypothesis that phosphate availability in the soil may vary when superphosphate is applied continuously under different shade trees, cannot therefore be taken as proved.

Phosphate status under bamboo shade.—An attempt was also made to assess the effect, if any, of shade *per se* on the availability of phosphate. Botany branch experiment F-207.0 on cutting beds under bamboo shade was made use of for this investigation. Bamboo screens of three meshes (cutting out 80%, 65% and 50% of incident radiation respectively) were used in this experiment and there were also unshaded plots. Each treatment was replicated three times. Soil samples (top 9″) were drawn on 18-1-1954, the bamboo covers were then put on and a second lot of soil samples was drawn on 10-11-1954, *i.e.*, after being under shade for about 10 months. The two sets of samples were examined for total and 1% citric soluble phosphate. The results were negative and no conclusions could be drawn from them.

There are reasons to believe that phosphate availability in the soil may be affected by the amount of organic matter turnover which takes place and the nature and degree of shade cover. Results from the two experiments quoted above are, however,

negative and inconclusive. It is proposed to pursue this investigation by using other methods for categorisation of soil phosphorus.

Effect of fertiliser treatment on exchange properties of soils :

Short term effects of Sulphate of Ammonia and oilcake treatments, Borbhetta area 8.3.—Soil samples (top 9″) were drawn in August 1954 from those plots of Borbhetta area 8.3 which had been treated with Sulphate of Ammonia and oilcake at the rate of 150 lb. nitrogen per acre. This experiment was started only in 1952 and the tea is partly under artificial shade, bamboo screens of two meshes being used as shade. The soil samples were tested for Base exchange capacity and Total exchangeable metal cations, both before and after destroying organic matter by ignition. A summary of the results obtained is given in table 7.

TABLE 7

Base exchange properties of soil, Borbhetta area 8.3

Fertiliser treatment 1952-54	Incident insolation	Means of four replicates, in m.e./100 gm. soil			
		Base exchange capacity		Total exchangeable metal cations	
		Original	After ignition	Original	After ignition
Sulphate of Ammonia @ 150 lb. N/ acre/year	100 (full sunlight)	5.3	3.3	0.8	0 3
	75	5.0	3.0	0.9	0.6
	50	5.3	2.5	1.0	0.6
Oilcake @ 150 lb. N/ acre/year	100 (full sunlight)	5.3	3.5	0.7	0.3
	75	4.8	2.0	0.9	0.8
	50	5.0	3.0	0.6	0.2
S. D. reqd. at P = 0.05		1.0	1.3	0.8	0.4

The differences in the values for the two manurial treatments are not significant.

The short term effects (in the above case, after three years of treatment) of Sulphate of Ammonia treatment are not visibly different from those of oilcake. In tea culture, the effects of

fertiliser treatment are, of course, masked by the turnover of organic matter which takes place automatically whatever the manure applied and the net effect is the complicated end-result of both these factors.

It is interesting to note that in both the above cases approximately 44% of the total Base exchange properties of the soil is contributed by the organic fraction. The base saturation of the above soil samples is about 14-17% only.

Long term effect of Sulphate of Ammonia treatment, Borbhetta area 7.—The soil samples from Borbhetta area 7 which have been described fully under paragraph 10 (see table 10 for details) were also examined for Base exchange capacity and Total exchangeable metal cations. Summaries of the results of chemical and statistical analyses will be found in tables 8 and 9.

TABLE 8

Exchange properties of soil, Borbhetta area 7

Fertiliser treatment	Jat of tea	Base exchange capacity in m. e./100 g.m. soil, means of four replicates, at depth			
		0″-9″	9″-18″	18″-27″	27″-36″
Initially 20, then 40 lb. N/acre/year (N_1)	Dark	4	4	4	4
	Light	4	3	4	4
Initially 60, then 120 lb. N/acre/year (N_3)	Dark	4	4	4	4
	Light	4	4	3	4
		Total exchangeable metal cations in m.e./100 gm. soil, means of four replicates, at depth			
		0″—9″	9″—18″	18″—27″	27″—36″
Initially 20, then 40 lb. N/acre/year (N_1)	Dark	0.5	0.6	0.1	0.2
	Light	0.4	0 3	0.3	0.2
Initially 60, then 120 lb. N/acre/year (N_3)	Dark	0.2	0.2	trace	trace
	Light	0.3	trace	trace	0.2

In the case of the data for Total exchangeable metal cations, the values were transformed for the purpose of statistical analysis, using the function

$\sqrt{10x + 0.5}$ (where x is the original value) and the results given in table 9 are in terms of the transformed units.

TABLE 9

Effect of Sulphate of Ammonia treatment on exchange properties

	Mean value, for fertiliser treatment		S. D. required
	N_1	N_3	
Base exchange capacity, m.e./100 gm. soil	3.6	3.8	0.5_9 at P= 0.05
Total exchangeable metal cations, m.e./100 gm. soil (but in transformed units)	1.8	1.2	0.2_6 at P= 0.05 0.5_1 at P=0.001

There has been a highly significant diminution in the Total exchangeable metal cations (*i.e.* the base saturation) of the soil under continuous treatment with Sulphate of Ammonia, although the Base exchange capacity has remained unaffected. The average percentage base saturation of the soil at the end of 20 years treatment with Sulphate of Ammonia is as follows:

In the case of treatment N_1, about 9%
,, ,, ,, N_3, ,, 3%

Long term effects of Sulphate of Ammonia treatment on soil acidity status, Borbhetta area 5 and 7.— A detailed study has been made of the long term effects of continuous Sulphate of Ammonia treatment on the acidity status of the soil profile to a depth of 3 ft., using two Borbhetta field trials, which commenced in 1936 and 1942 respectively, for this investigation. Soil samples were drawn in the summer of 1955 at four depths (0″–9″, 9″–18″, 18″–27″ and 27″–36″) from those plots of Borbhetta areas 5 and 7 which had received continuous treatment with Sulphate of Ammonia, details of which are given in table 10.

The areas sampled have received no fertiliser treatment other than that with Sulphate of Ammonia.

TABLE 10

Long term Sulphate of Ammonia treatment plots, Borbhetta areas 5 and 7

	Borbhetta area 5.	Borbhetta area 7.
Details about tea	Jat Deamoolie, planted November 1932, 4 ft. square, half the plots shaded (Albizzia stipulata) as from 1942 and the other half unshaded	Two jats of tea (light and dark leaf Silbhetta), planted November 1935, 4½ ft. triangular, whole area under shade (Albizzia stipulata) as from 1947.
Fertiliser treatment for plots sampled	Check and S.O.A. applied at three levels, i.e., at the rates 0, 30, 60 and 90 lb. N./acre/year respectively, during the periods 1942-45 and 1947-55.	S.O.A. applied at two levels, i.e., at the rates 20 and 60 during the period 1936-46 and 40 and 120 lb N./acre/year, respectively during the period 1947-55.
Total amounts of N. applied to the plots sampled, lb./acre	0, 390, 780 and 1,170 respectively, over a period of 14 years.	589 and 1,749 respectively, over a period of 20 years.
Replicates	Four for each level of nitrogen and shade	Four for each level of nitrogen and kind of tea

All the samples were tested for pH of water and KNO_3 extracts and lime requirements (Hopkin's method). The results are presented in table 11 and in plates 1 and 2. In working out pH averages, the data was converted to H ion concentrations first, the means calculated and the figure so obtained re-converted to the pH scale.

Although the effects of the smallest dose of Sulphate of Ammonia are not pronounced, the progressive change in the soil acidity status of the Borbhetta soil right down to a depth of 3 ft., with continuous treatment, is brought out clearly. The fact that Sulphate of Ammonia increases soil acidity has been

known for a long time but it is interesting to record the magnitude of the changes after 13/20 years of continuous treatment. Statistical analysis shows the fertiliser effect to be highly significant in all cases with the sole exception of the "Lime requirement" result in the case of Borbhetta area 7. The pH value of the water extract of the soil has dropped to well below 4.0 in the case of those plots which have received the highest dose of Sulphate of Ammonia, the original pH value for the soil being just over 4.5. The tea, however, is still in good condition and, as yet, shows no ill-effects.

The pH of the KNO_3 extract also shows a pronounced change with continuous Sulphate of Ammonia treatment although the change is less than half the corresponding value for water extract. The increase in exchange acidity is presumably proportional to the loss in the exchangeable metal cations which results from continuous Sulphate of Ammonia treatment. The "Depth × Nitrogen" interaction is highly significant in the case of KNO_3 extract data for Borbhetta area 5.

A comparison of the results for the two trials shows that as the soil becomes more and more acid under Sulphate of Ammonia treatment, it becomes progressively more resistant to change. The magnitude of the effects on soil properties of a given application of Sulphate of Ammonia diminishes under continuous treatment and presumably there is a limiting value which is reached ultimately. It would be interesting to repeat these tests at the end of another 5 years or so, to find out what further changes, if any, occur in the soil acidity status.

TABLE 11

Soil acidity, treatment averages (means for 8 plots), Brobhetta areas 5 and 7: (see also plates 1 and 2).

	Fertiliser treatment lb. N/acre/ year	pH of water extract, at depth				pH of KNO_3 extract, at depth				Lime requirements, p.p.m. at depth			
		0″-9″	9″-18″	18″-27″	27″-36″	0″-9″	9″-18″	18″-27″	27″-36″	0″-9″	9″-18″	18″-27″	27″-36″
Brobhetta area 5	0	4.56	4.51	4.54	4·59	4.02	3.92	4.08	4.10	789	853	1,117	1,198
	30	4.46	4.35	4.39	4.38	4.03	3.95	4.08	4.04	783	930	1,078	1,209
	60	4.29	4·25	4.29	4.25	3.90	3.79	4.06	4.00	1,008	1,011	1,209	1,373
	90	4.20	4.16	4.15	4.14	3.76	3.75	3.98	3.89	1,036	1,129	1,351	1,596
	S. D. reqd. at P=0.05	**0.17**				**0.05**				**168**			
Brobhetta area 7	20 and 40	4.25	4 23	4.24	4.34	3.38	3.84	3,85	3.84	1,152	1,367	1,709	2,030
	60 and 120	3.97	3.97	4.10	4.10	3.80	3,74	3.78	3.79	1,321	1,480	1,916	2,102
	S. D. reqd. at P=0.05	**0.17**				**0 07**				**290**			

PLATE 1: CHANGES IN SOIL ACIDITY STATUS UNDER S.O.A. TREATMENT, BORBHETTA AREA 5

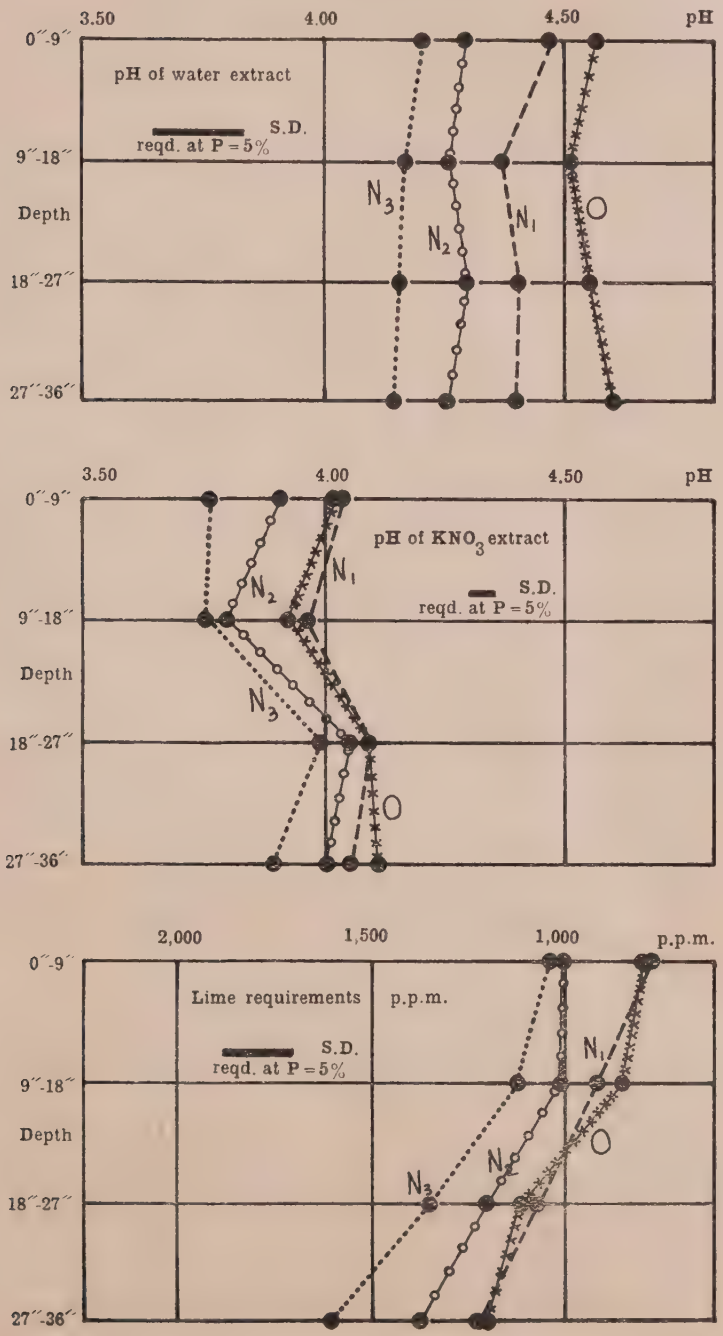
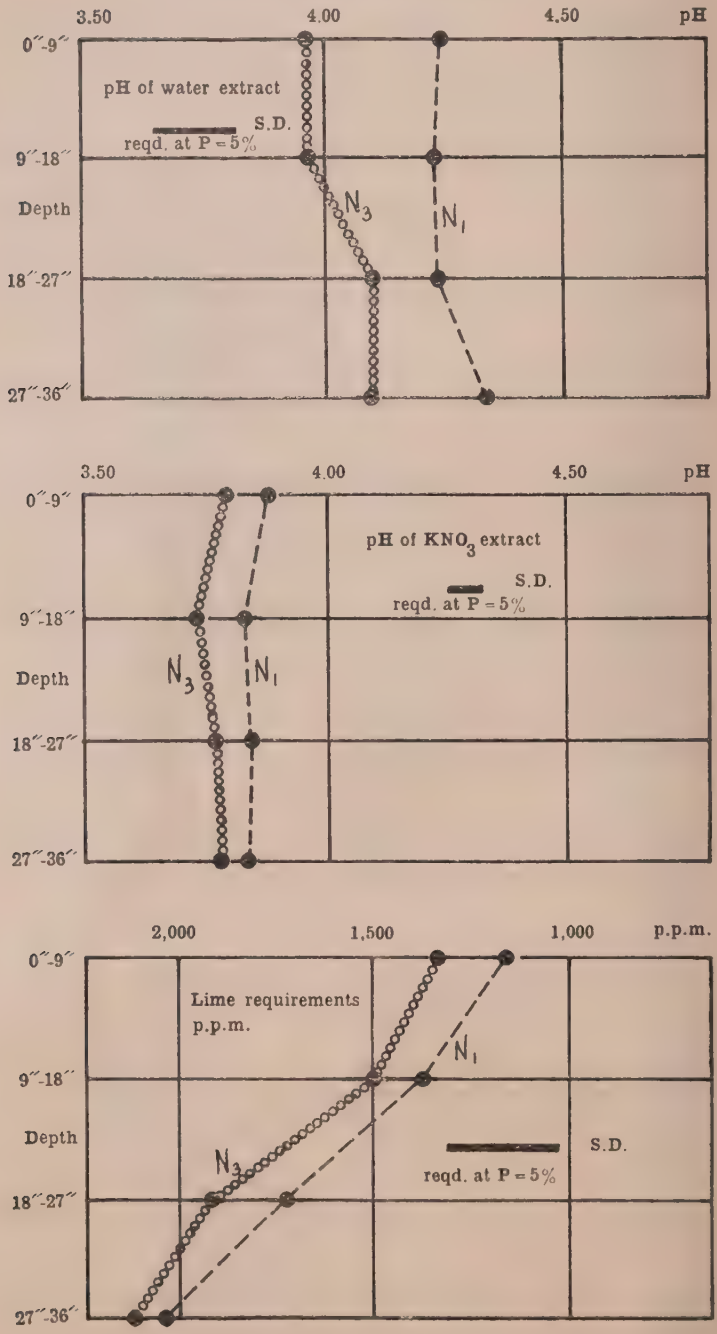


PLATE 2: CHANGES IN SOIL ACIDITY STATUS UNDER S.O.A. TREATMENT, BORBHETTA AREA 7



METEOROLOGICAL OBSERVATIONS

Tocklai meteorological observations 1955 :

TABLE 12

	Monthly average temperature °F		Sun shine (hrs)	Rain-fall (inches)	No. of rainy days	Average	
	Max.	Min.				Rain-fall	Rainy days
January ...	72·1	50·4	6·4	0·47	5	0·87	5
February ...	77·0	54·6	6·8	0·24	5	1·28	8
March ...	80·8	60·5	5·8	4·68	14	3·57	11
April ...	83·1	65·0	7·2	6·81	12	7·80	17
May ...	86·1	72·4	6·1	9·97	16	10·68	20
June ...	87·1	75 2	5·0	10·56	17	12·83	23
July ...	88 9	76·4	4·4	12·17	27	14·91	25
August ...	88·9	75·5	4·8	19·55	25	13·11	23
September ...	89·5	75·2	6·2	8·80	18	10 55	20
October ...	85·0	70 9	5·1	11 10	17	4·66	12
November ...	80·3	59·7	6·3	1·40	3	1·08	4
December ...	72·6	49 5	5·9	0·67	3	0·43	3
Total ...			70·0	86·42	162	81·77	171
Average ...	82·6	65·4	5·8				

TABLE 13

% Relative Humidity (monthly averages), 1955

Hrs. I. S. T.	Jan.	Feb.	Mar.	Apr.	May,	June	July	Aug.	Sep.	Oct.	Nov.	Dec
0613	95	94	92	91	91	92	93	95	95	97	98	98
1313	57	52	56	58	70	74	75	74	72	76	68	64

TABLE 14

Vapour Tension, 1955 : (in inches of mercury, monthly averages)

Hrs. I. S. T.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
0613	.374	·425	.515	.609	.795	.877	.899	.899	.910	.799	.553	.380
1313	·439	.453	.528	.595	.814	.889	.941	.930	·941	.837	.652	.476

TABLE 15 :

Soil Temperatures °F, Soil Moisture and Evaporation from a standard evaporimeter.

1955	Soil Temp at 1 ft.				Soil Temp. at 3 ft.				% Soil moisture (top 9")		Evaporation (inches) daily mean
	Bare		Grass		Bare		Grass				
	at 0613 IST	at 1313 IST	at 0613 IST	at 1313 IST	at 0613 IST	at 1313 IST	at 0613 IST	at 1313 IST	Morning	After noon	
January ...	64.8	64.4	65.8	65.7	69.0	68.9	67.5	67.4	12.2	?	0.057
February ...	67.9	67.6	68.6	68.5	70.0	70.2	69.3	69.2	12.8	?	0,091
March ...	72.2	71.7	72.6	72.4	72.7	72.9	72.6	72.6	13.3	?	0.111
April ...	76.4	76.0	77.4	77.1	76.0	76.2	76.6	76.6	15.8	15.5	0.150
May ...	80.6	80.4	81.7	81.5	78.1	78.3	79.9	80.0	17.0	16.8	0.172
June ...	83.4	83.0	84 5	84.2	80.4	80.5	82.8	82.8	18.3	18.0	0.158
July ...	85.8	85.4	86.9	86.7	82.7	82.7	85.5	85.3	18.7	18.6	0.166
August ...	85.3	84.8	86.1	85.9	82.4	82.4	85.0	84.8	18.7	18.5	0.149
September ...	86.1	85.6	86.7	86.6	83.5	83.5	85.7	85.5	17.8	17.4	0.136
October ...	82.7	82.3	83.9	83.7	83.2	83.3	83.8	83.7	17.8	17.6	0.107
November ...	75.1	74.6	76.7	76.5	78.5	78.6	77.9	77.8	16.4	16.0	0.075
December ...	67 5	67 0	69.0	68.8	72.9	72.9	71.4	71.3	15.7	15.5	0.050

BOTANICAL BRANCH

The Botanist (Mr. M. J. Green) returned to duty on 6th April, 1955. The Senior Botanist (Dr. W. Wight) left Tocklai on February 20th to represent the Station at the Eleventh Biennial Conference of the Tea Research Institute of Ceylon, and was on tour in Ceylon, South India, Darjeeling and the Dooars until March 22nd (31 days). He toured in Doom Dooma April 6th to 8th (3 days) and again in the Dooars from November 26th to 30th (5 days). Total touring 1955: 39 days.

The Senior Botanist functioned as Acting Director as follows:

February 1st to 3rd	...	3 days
July 11th to October 5th	...	87 ,,
November 17th to 20th	...	4 ,,
November 4th to 10th	...	7 ,,
Total acting 1956	...	101 ,,

The Senior Botanist was occupied with field work at Borbhetta for most of the second quarter (apart from 11 days as Acting Director) in connection with the resumption of tea breeding. No new matings had been made since 1952 and a considerable amount of re-organisation was necessary and is not yet completed. Mr. Green is gradually taking over this work.

The various activities enumerated above necessarily interfered with a programme of publication that had been drawn up earlier, and will be followed by a reduction in the number of botanical publications in the year 1956. The following papers and articles were published in 1955:

Wight, W. and Barua, D. N. The nature of dormancy in the tea plant. Jour. Exp. Bot. *6*: 1-5.

Wight, W. Dormancy in relation to plucking and pruning of the tea plant. Phytomorphology *5*: 1-11.

Wight, W. Selection and seed production policy in Assam. Jour. Tea Res. Inst. Ceylon *26*: 72-76.

Wight, W. Commercial propagation of Camellia sinensis in India. American Camellia Year Book 1955: 88-100.

Wight, W. and Barua, P. K. Pretreatment of tea cuttings for distribution by mail. Jour. Hort. Sci. *30*: 129-130.

Wight, W. and Gokhale, N. G. Longevity of the tea plant and the rational use of tea garden land. Commercial Times (India) 11(5) ; 22-28.

Programme, 1956

Tea breeding. Long term project.

Morphology and anatomy. Definition of species and varieties.

Definition of hybrid populations in relation to economic value.

Illumination and nutrients. Effect of fertilisers on growth of defined clones and populations, and the modification of growth by shade.

BOTANICAL RESEARCH AT TOCKLAI

W. Wight and D. N. Barua

In India and Ceylon, tea bushes are usually, but not always, grown "under shade"—*i.e.* under the canopy of specially cultivated forest trees: this is known to increase yield. It was shown in 1951 (Area 34, Borbhetta) that a canopy of horizontal bamboo screens significantly increased the yield of a tea bush population that had not previously been under shade: an increase noted within five weeks was maintained during three years of observation and did not differ significantly from the 50% increase recorded for a comparable population of the same seed origin growing under trees. It is therefore concluded that one of the desirable conditions set up by shade trees is the presence of a canopy. Parallel experiments by D. N. Barua on seedlings and on young plants of Tocklai clones, growing under controlled conditions at Cambridge, indicated that a physical factor of primary im-

portance is light intensity. Connected field trials using both trees and bamboo screens, were independently described by Dutta (Tocklai Ann. Rep. 1953 : 7-27) and have been adequately reviewed by Portsmouth in the Tea Quarterly (Ceylon) for December 1954, Vol. 25, pt. 4, pp. 80-83.

The yield of tea under a shade tree canopy can generally be (further) increased by nitrogenous manures: this increase is modified by conditions the study of which is of great practical importance. Investigations in the form of large field trials were commenced for the Scientific Department of the Indian Tea Association by Cooper in 1936 and continued by Macgregor and then by Glover. The use of bamboo screens was introduced by Woodford and continued by Wight and Dutta until these researches were taken over by D. N. Barua in 1955. A brief account of earlier work, therefore, is given in anticipation of detailed treatment elsewhere by workers concerned. Statements in the present account do not imply finality and are intended only to describe the general nature of research.

In 1952 the top parts of some of the shade trees in an existing trial (Area 45/47) were removed at ground level and replaced by a canopy of bamboo screens, when it was found that the yield associated with screens plus sulphate of ammonia did not differ from the yield associated with shade trees plus sulphate of ammonia ; but in subsequent years screens in the presence of sulphate of ammonia resulted in a lesser yield than trees in the presence of sulphate of ammonia. The absence of a difference in the first year was ascribed to a positive residual effect of the trees remaining operative under the screens ; and it was concluded that some trees make available certain substances and/or create certain conditions necessary for the efficient utilisation of inorganic nitrogenous manures under an overhead canopy: the canopy could be that of the trees themselves. Incomplete investigation of twelve different populations indicates that superphosphate may be superior to sulphate of ammonia in causing yield increase under bamboo screens, at least in some populations ; and under these conditions it is possible that substances present in superphosphate may be associated with better utilisation of nitrogen from our soils.

On the other hand a parallel experiment, using a population the yield of which had been increased 50% by bamboo screens (Area 34, Borbhetta), showed inorganic N P K mixture to be entirely without effect under the screens either in the first year (1951) or in subsequent years; but this observation is inconclusive as population interactions (Ann. Rep. 1954: 30-38) admit the possibility of the same treatment having a different effect on some other population. The experiment, however, shows that it is possible to establish canopy conditions that raise the yield of some populations to a satisfactory level that is not exceeded when a commonly used mixture of inorganic nutrients is added to the soil. There is evidence to show that similar conditions sometimes exist on tea estates where shade trees have satisfactorily increased the yield of tea but sulphate of ammonia used under the trees has been without further effect on yield. In evaluating this and similar evidence, genetical factors are of primary importance: for instance, experiments under bamboo covers (Area 1, Tocklai: 1948-49) showed that differences between the Assam and the China tea plant are likely to determine the relative yield increases under a canopy, due to sulphate of ammonia and to superphosphate; and it seemed that better replication might show a similar canopy, in the absence of nutrients, to depress the yield of the China plants.

The foregoing observations give the background of a long term series of investigations of the effect of manures on tea bushes growing under a shade canopy. For administrative purposes these investigations have been considered under a programme head of Illumination and Nutrients: they have shown that a canopy soon sets up conditions good for the growth of the tea bush; but these conditions can be better when the canopy is provided by a living tree. This improvement might be due to one or other of several factors associated with the tree; for instance, minor elements in leaf litter might be important, but in another place their value might be negligible in comparison with a loosening of the soil brought about by growth of the tree roots. Definition of immediate causes is less important than a proper appreciation of various benefits latent in a shade tree becoming effective under one condition or another.

An outstanding problem is whether the residual effect of trees which we have observed under bamboo screens, is to be associated with tree roots that remained in the soil, or with the litter of leaves and pods deposited on the soil before the tree tops were removed. Of more immediate importance is the conclusion that relative yield of populations permanently under bamboo screens of a suitable mesh size is likely to be a useful approximation to their relative yield under shade trees; and this raises the question as to how quickly and in how small an area can relative shade yield be determined under bamboo screens ?

In this connection, the ten-year yields of several populations originating in disparate seed sources, have been significantly correlated with the size of vessels and wood fibres in the leaf petiole measured on only one occasion in one year. Other morphological criteria are known, and if applied to seedling populations under an experimental canopy of bamboo screens might replace some large field trials by smaller designs of comparatively short duration. These possibilities are being investigated by D. N. Barua.

Shade trees are deciduous and may be leafless for long periods. In experiments so far bamboo canopies have remained permanently in position. In one instance bamboo screens failed to increase the yield of a clone; but after the removal of the screens at the end of the year, increased shoot growth was recorded in the following spring (second flush period) at the time when shade trees are normally leafless: records were not continued. The observation shows that interaction of yield with periodic foliation of shade tree is possible: but at the moment we incline to the opinion that an appreciable part of the yield associated with periodic foliation/defoliation will be mainly a redistribution of an innate total that might be estimated under permanent screens. Seasonal distribution of yield is known to differ between progenies and this factor is likely to interact with seasonal changes in the canopy.

The effects of canopy and manures on a population can have general meaning only if the nature of the population is specified in a way that permits relevant comparison with other populations. It is impossible to obtain tea seed from bushes

plucked in the manner usual in Assam. Seed, therefore, is repeatedly obtained from perennial orchards specially maintained for the purpose. This leads to a crop structure in which populations widely separated in space and time have identical genetical composition: they are said to be of the same jat. Many jats have an origin in hybrids between the Assam and the China varieties and show the features of one or other of the parental forms in varying degree. Jats differ greatly in their reactions to shade trees and nutrients: thus the morphological definition of populations *in relation to their response to nutrients and shade conditions* is a matter of the greatest importance. Work of this nature, completed in 1955 under the programme head of Morphology and Taxonomy, will be published elsewhere. The balance of the botanical work at Tocklai falls under the third head of Tea Breeding, the nature of which will be clear from an account in the latter part of this report.

ILLUMINATION AND NUTRIENTS

D. N. Barua

Calcium oxalate crystals as an index of nutrient uptake in the tea plant (Reported 17 February, 1956).— The frequency of calcium oxalate crystals in the tea plant (*Camellia sinensis L.*) has been shown to differ between clones and between populations raised from disparate seed sources (*jats*)[1]. A standard crystal count, called *phloem index*, was defined as the total number of crystals in the phloem parenchyma of a complete cross section of the leaf petiole: this was considered to be indicative of the K/P balance of the tea plant. It was further shown that regeneration of shoots in response to plucking is related to phloem index.

Subsequently, leaf-stalk injection described by Roach[2] was used to study change of crystal frequency caused by nutrients injected into the vascular system. Growing shoots on unplucked bushes were used. The apex of these shoots is a compact structure from which leaves unfold at intervals. On a growing shoot, the leaf wrapped around the apex and the four unfolded leaves below this are increasing in area.

Preliminary observations were made on the movement of dye from one leaf to another. Fully expanded leaves in various positions on the stem were injected with 0.25% acid fuchin. Tea has a 2/5 phyllotaxis. The dye permeated the second and third leaves above and below the one injected. The fifth leaf above injection point was sometimes permeated, possibly when a large amount of dye was taken in by the injected leaf. The pattern of distribution of the injected dye was the same as that observed by Roach in pear (with the same phyllotaxis as tea).

Roach[2] found dye permeation to increase in proportion to reduction in size of the leaf used for injection. In our work a larger volume of solution might have been injected by using a shorter basal piece of leaf, but it was difficult to work speedily with less than one third of the mid-rib plus petiole and this length (approximately 1.0 inch), therefore, was used throughout the experiment.

When the third, immature, leaf below the apex of a tea shoot was injected, then dye permeated only the second leaf above and below injection point, but some colouration was seen in the upper third leaf which was wrapped around the apex at the time of injection.

The third leaf below the apex was used for nutrient injection. The lamina of the basal one-third of this was trimmed and the remaining stalk immersed in solution contained in a glass vial (3/8″ × 2″) between 10 a.m. and 1.0 p.m. (local time) on 10th October 1955. Vials were removed at 10 a.m. on the following day.

Petioles of the second and third leaves above injection point were used for crystal counts These leaves had well developed vascular tissue on the date of injection and were respectively 20 to 25 days short of attaining their maximum area (approximately). Crystal counts were made 6 weeks after injection.

Three bushes in each of four clones were used, all the bushes being contained in an area of approximately 50 × 50 feet. Ten shoots on each bush were selected for injection, two for

each nutrient solution and two for controls. The nutrients, in distilled water, were as follows:—

Urea	...	...	0.25%
Potassium sulphate	..	...	0.25%
Calcium chloride ($2H_2O$)		...	0.25%

Distilled water.

Concentrations of potassium sulphate and calcium chloride higher than the foregoing caused a marginal necrosis resembling the condition commonly known as "rim blight": this is considered to be a metabolic disturbance. "Rim blight" can be induced by inorganic manures applied during early stages of shoot growth following pruning. In this connection it is to be noted that potassium sulphate used as a fertiliser can induce more rim blight than ammonium sulphate.

The analysis of variance of phloem index is given in Table I and results for treatments, clones and leaves, in Tables II to IV. In the concentrations used for injection, urea and potassium sulphate reduced the crystal frequency to less than that of untreated leaves. Crystal frequency did not differ between untreated leaves, leaves injected with water and leaves injected with calcium chloride. In confirmation of previous observations, a limited range of crystal frequency was found to be characteristic of a particular clone.

Injected urea, and also ammonium sulphate when applied to the soil' both reduced crystal frequency, from which it can be presumed that uptake of certain nutrients by the roots will determine crystal frequency within genetical limits. Crystal frequency, therefore, appears to be a sensitive quantitative index of metabolic changes associated with nutrient uptake which could be used to investigate the relation of the tea plant to environment. When a standard clone has a constant crystal frequency in several locations then a difference between crystal frequency caused by injection and crystal frequency caused by application of the same nutrient to the soil may alter with locality, and so indicate soil variation of importance for the growth

of the tea plant. The nutrients required for the cultivation of tea are likely to be those that when injected cause a reduction in crystal frequency.

TABLE I

Analysis of variance of phloem index

Source of variance	D. F.	Mean square	F
Between clones	3	52932.9	130.75 ***
Within clones	8	404.8	
Bushes	11	14730.7	
Treatments (nutrients)	4	1969.4	8.03 ***
Bush x treatment	44	245.3	
Leaf position	1	1230.5	4.97 *
Position x treatment	4	317.4	
Remainder	165	247.7	
Total	229x		

x Degrees of freedom adjusted for missing values.
* Significant at 5% level.
*** Significant at 0.1% level.

TABLE II

Mean phloem index for treatments

Urea	Potassium sulphate	Calcium chloride	Distilled water	Control
69.7	73.7	82.5	81.3	85.5

Difference required for significance (P = 0.05) : 6.8

TABLE III

Mean Phloem index for clones

Clone	16/10/22	19/19/8	19/10/3	19/27/11
Phloem Index	90.0	73.5	112.8	41.1

Difference required for significance (P = 0.05) : 8.8

TABLE IV

Mean phloem index for leaves

2nd leaf	3rd leaf
76.3	81.0

Difference required for significance (P = 0.05) : 4.1

Literature cited

1. Wight, W. and Barua, D.N., Calcium oxalate crystals as an indicator of nutrient balance in the tea plant (*Camellia sinensis*). Current Sci., 1954, *23*. 78-79.

2. Roach, W. A., Plant injections for diagnostic and curative purposes. Imp. Bureau of Hort. and Plantation Crops, Tech. Comm. No. 10, 1938.

Yield Equations.— Trials at Borbhetta and elsewhere have shown that yield increase in full sunlight is proportional to nitrogen dosage up to 120 lbs. per acre: even when the dosage rises to 160 lbs. there is not a marked deviation from linearity. This is the general case for common jats of tea grown without shade in North India.

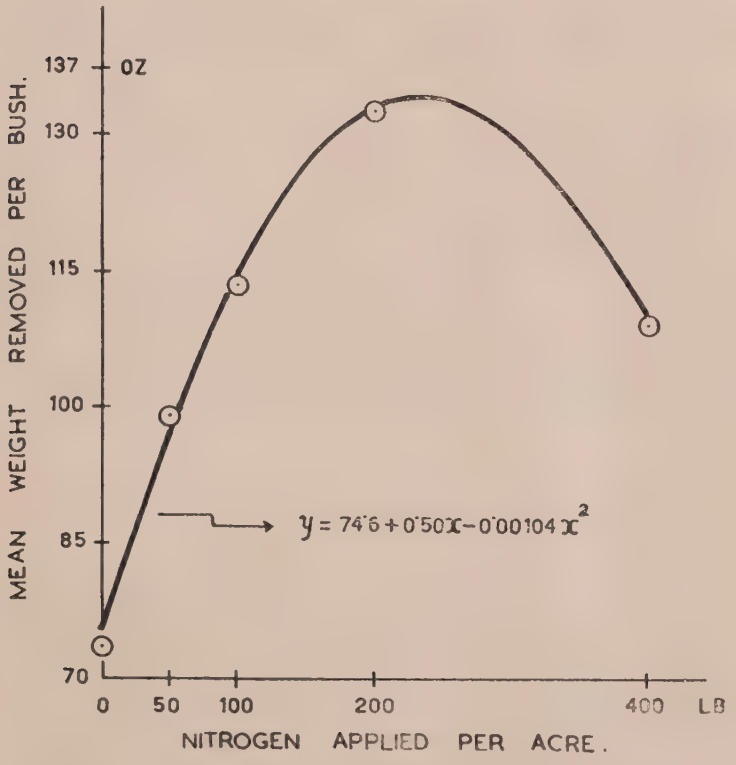
The linear response is, of course, an approximation within the limits. A more precise representation of the equation connecting yield and nitrogen dosage is of theoretical interest and was discussed at length in our Memorandum No. 76 dated March 1952 (Appendix to Quartely Report, March 1952). We give below an analysis of some of the data on which our views were based.

Plots of 18-20 mature bushes of a dark leaf Assam jat were manured at the rate of 0, 50, 100, 200, 400 pounds of nitrogen per acre as sulphate of ammonia applied in May. Plots were twice replicated. The bushes were not plucked, but extension growth was removed twice per year, in May and October, leaving only a short basal stub on the permanent frame of the bush. This is the system used for vegetative propagation, but in this instance small random samples of stems were removed for propagation and the bulk of the stems were allowed to decay on

the soil. Manuring commenced in 1949 and continued until 1953. During this period no noticeable pathological effects were associated with the highest nitrogen dosage.

Growth was recorded as ounces of cut stems per bush for the period 1950-53. The error degree of freedom for nitrogen is very small but useful information can be abstracted by partitioning the variance due to nitrogen into linear and quadratic components. The quadratic component becomes highly significant in comparison with random fluctuations ($error_1$). The residual, after extraction of the quadratic component, is negligible.

Fig. 1.



Relation between weight of growth and nitrogen dosage.

The analysis of variance is given in Table V and the extremely good fit of the quadratic equation with the observed points is illustrated in Fig. 1. The calculated maximum of the curve is at 240 lbs. of nitrogen.

These observations confirm our statement of March 1952 that "a mode of growth is reached and further doses of nitrogen result in a reduction of growth". This, and other reasons, led us to believe that no generally satisfactory yield equation of tea can be formulated unless it permits yield to decrease on either side of a mode.

TABLE V

Source of variance.		D.F.		Mean S.S.	F.
Replicate		1		640	
Nitrogen doses	Linear regression	1		4,133	10.33 *
	Excess due to quadratic	1	4	10,788	26.96 **
	Residual	2		42	
$Error_1$		4		400	
Year		3		2,674	19.66 ***
Year x Nitrogen doses		12		51	
$Error_2$		15		136	
Total		39			

*, **, *** : Significant respectively at 5%, 1% and 0.1% level of probability.

PRACTICAL TEA BREEDING

W. Wight and P. K. Barua

The object of the Association's tea breeding programme is the production of improved tea seed. The execution of the work was in the hands of Mr. P. K. Barua from 1940 until early 1953 when the Agriculturist (Mr. S. K. Dutta) became responsible for the practical aspects of tea breeding. In April 1955 the breeding records of both the Agricultural Branch and the Botanical Branch were taken over by Mr. M. J. Green (Botanist).

The following paragraphs do not pretend to give a comprehensive report: instead, they give a simple account of one aspect

of the work—that of breeding for the qualities known as "Assam tea". The account is illustrated by a restricted number of examples from the numerous progenies now in existence, as this is probably more acceptable than the detailed reports that have been submitted by the Senior Botanist every other year commencing with 1945.

Excellent sources of seed giving rise to plants that make desirable Assam tea, are available in the Brahmaputra valley: these are the well known Tea Seed Estates and Tea Seed Companies. Some of these have been practising mass selection for nearly fifty years and have undoubtedly improved the indigenous tea of the Province: this fact is not sufficiently well known.

Mass selection succeeded in producing modern Assam seed because the morphological features that appeared desirable happen to breed true; and because they are linked with a pungency and flavour that made the tea unique. This must have been known to the enthusiasts who commenced the work; but their attempts to introduce the qualities of Assam tea into more hardy kinds of plant by deliberate crossing followed by mass selection, did not succeed. This failure has been followed by the use of modern jats in situations that would be better suited to hardier kinds of plant.

Thus an important task of the breeder is to introduce the characters of Assam tea into other kinds of plant adapted to a wider range of conditions. Mass selection will not suffice for this: line breeding leading to vegetatively propagated clonal sources of seed, is necessary.

As soon as a progeny is produced in which the plants are not too heterogenous to make the pruning of large populations troublesome; and as soon as the shoots plucked from the entire progeny and manufactured together, make a tea that is better than usual; then a new standard has been set that can be exploited commercially, provided that the yield is not lower than that which obtained previously.

Reciprocal matings generally give identical results: most tea plants set very little seed with their own pollen, some none at all; and thus, if suitable clones are used for the production of an experimental progeny by controlled or artificial pollination, then a substantially similar progeny could be expected to follow the free transfer of pollen when the two clones are interplanted; provided that the orchard so constituted is isolated from foreign pollen. Whilst this has yet to be demonstrated, the immediate object of tea breeding remains a bi-clonal source of seed; and with this end in view, numerous experimental matings have been made during the past 16 years.

Morphologically distinct plants selected from estates and from introduced material, have been used. It is estimated that these selections can lead to useful improvements in three generations. The main requirement is first hand knowledge of the breeding behaviour of particular plants: for instance, some plants are useful pollinators for a wide range of material. Depending on the nature of the parents used for the initial mating, the first generation might be satisfactory; but further matings might be needed to ensure that the final progeny originates in parents that are easy to propagate vegetatively.

The usual time required for one generation, including the manufacture of shoots from individual plants, is about seven years, but it is sometimes possible to halve this period if rapidly maturing plants can be judged on morphological criteria, and if they are required only as pollen parents. It is not always appreciated that one tea plant, even after seven years, is unlikely to produce sufficient seed for the next generation. Vegetative multiplication of selected plants is nearly always necessary, and time can be saved by grafting the selected material on to old rootstocks: the scion behaves as if of the age of the stock, and seed is produced at least two years earlier than from material multiplied by cuttings. So far, all experimental progenies have been obtained by this method, as it enabled us to make large numbers of matings with an efficient output of seed, in the very small area originally allocated to the work. Unfortunately, the skilled labour that made this possible, is no longer available.

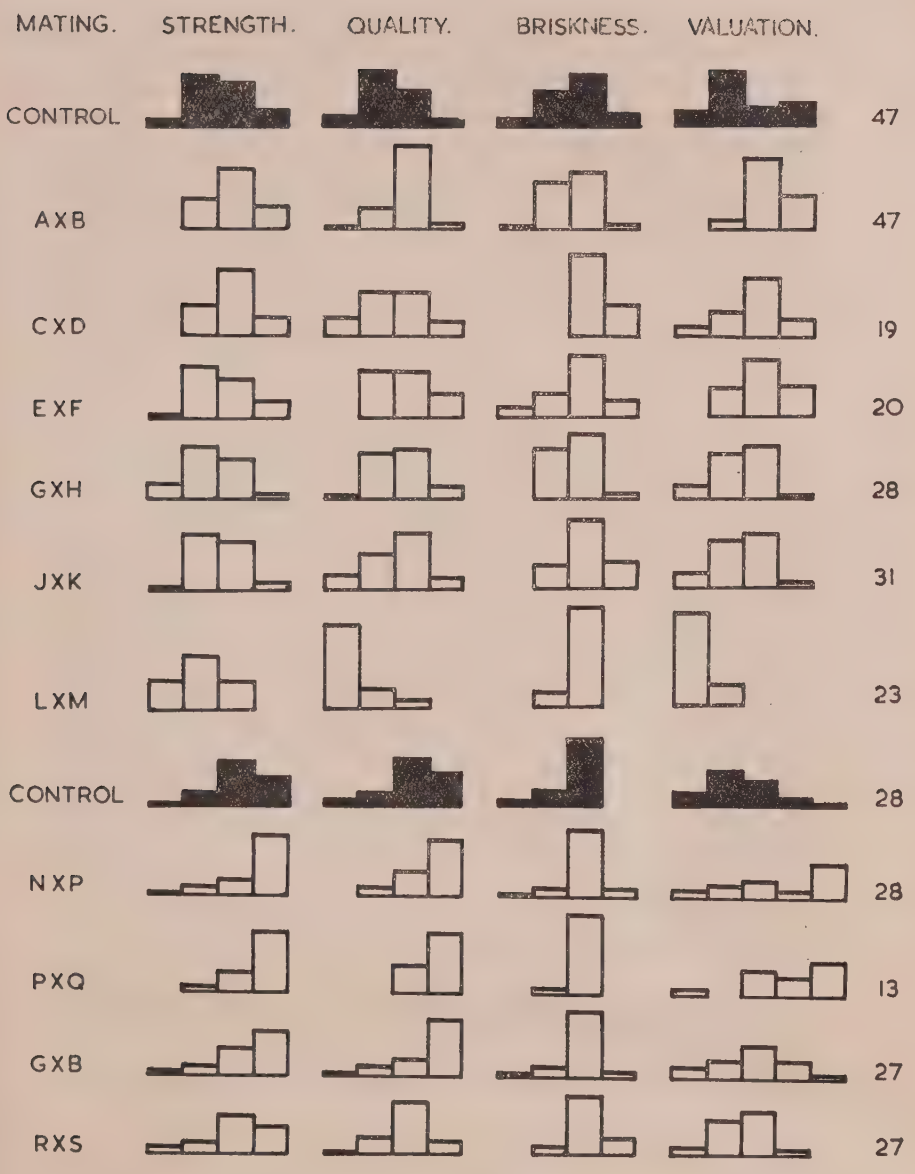


Fig. 2.

Tasters reports on ten progenies. Column height gives relative frequency of poor, good, better, best reports on strength, quality and briskness. Numerals on the right give the absolute number of reports on manufactures spread over the manufacturing season. The upper control is comparable with the first six progenies ; the lower control with the last four progenies in which a fifth category of value was attained sufficiently often to require separate record. Difference between controls is due to seasonal and block factors. Samples known to the taster only by numbers randomised on every occasion.

The accompanying diagram (Fig. 2) illustrates the nature of the tea made from ten progenies. The figures are constructed from tasters reports in the following way: the adjectives used by the taster to describe the tea are grouped into four categories—poor, good, better, best; and the frequency occurrence of reports within each category is recorded. Thus the vertical height of the columns gives the relative frequency of reports in the four categories in order of merit from left to right. The same procedure is followed for three attributes of the tea, and for cash valuation. The control is a modern Assam jat of the highest quality. Positive bias of the polygons relative to the control, indicates improvement.

Two important features of these matings are the homogeneity of plants within a progeny, and diversity of type between the progenies: thus there are reasons for believing that the progenies will be severally adapted to various environmental conditions. The yield of most of these progenies in small trial plots at six years of age, was not less than that of the control. Exceptions to this statement are N × P, P × Q, G × B and R × S of which plot replicates were inadequate for assessment of yield; and J × K where yield based on five replicates was significantly 50% greater than the control. This progeny is morphologically similar to the China variety which ordinarily makes tea quite unacceptable by Assam standards: the mating thus raises the possibility of Assam tea from a notably hardy kind of plant: these seed bearing clones have been multiplied as a bi-clonal bari (orchard) to provide seed for field trials elsewhere. Along other lines, breeding has not progressed far enough to justify a final choice of material.

The progeny L × M, with yield the same as the control, is quoted for the benefit of optimistic amateurs: it is the result of mating two good looking plants accepted entirely on tea estate standards.

AGRICULTURAL BRANCH

S. K. DUTTA—Senior Agriculturist
S. BASU—Assistant Agriculturist

Staff.— Mr. S. Basu joined in the post of the Assistant Agriculturist on the 28th February 1955.

Mr. B. K. Saikia joined as the Junior Agricultural Analyst on the 1st March 1955.

Mr. Nobin Chandra Bordoloi joined as the Mechanic on the 1st March 1955.

Dr. P. C. Sharma, Additional Advisory Officer, was in training in this branch from 15/6/55 to 3/12/55.

Labour.— The average daily attendance during the year was—

Tocklai	...	...	...	22.3
Borbhetta	...	...	...	351.40

Provident Fund Scheme for labourers was introduced from the 12th September 1955.

Crop Yield.— The total yield of green leaf during the year compared with that of 1954 was as follows:—

1954	...	...	...	2,33,543 lbs.
1955	...	...	...	2,43,788 lbs.

Of the 1955 yields, 2,25,380 lbs. were sold to Messrs. Jorehaut Tea Co., Ltd.

General plucking was stopped from the 18th November 1955.

Advisory.— 223 letters were written by the branch in answer to queries on technical matters.

Tour.— The Senior Agriculturist visited 42 gardens in the Dooars, Cachar and Assam during the year. He also attended the Annual General Meetings of the Dooars Branch

Indian Tea Planters' Association and Assam Tea Planters' Association on 10th February 1955 and 30th April 1955 respectively.

Publications and Lectures.— "Skiffing of Tea in the Rains" was re-written by the Senior Agriculturist in Tea Encyclopaedia, Serial No. 66/1, filed under G. 2.

The following were published during the year—

(*a*) "*Tea Cultivation in North-East India*"—by S. K. Dutta—"The Planters Journal and Agriculturist" August, 1955.

(*b*) "*Effect of reduced light intensity and nitrogenous manure on the cup characters of made tea*"—*by* S. K. Dutta and S. Basu—"Tea Trade and Industry", Vol. IV, No. 7, 1955.

The Senior Agriculturist gave a series of lectures on vegetative propagation during two special courses in May 1955.

Buildings.— Nine pucca labour quarters, one godown and one dispensary were built at Borbhetta during the year.

Expt. B.22.1—Three Year Pruning Cycle.—

This experiment is being conducted in a section of Rajgarh tea planted in 1924 at 4′ 6″ triangular. There are four treatments, each replicated four times, giving 16 plots, each of which consists of 100 bushes.

Preliminary yields were taken in 1948, and all subsequent yields have been related to these by co-variance analysis.

The first treatments were applied in 1950 and so far two full cycles have been completed.

Observations have been taken on yield of plucked leaf, cup characters of the made teas and susceptibility to diseases and pests.

The treatments are as follows:—

	Year.	Treatment 1	Treatment 2	Treatment 3	Treatment 4
CYCLE 1	1950	Prune 27″ Pluck 35″	Prune 27″ Pluck 35″	Purne 27½″ and knife clean Pluck 35″.	Prune ½″ up and knife clean. Pluck 8″ to janam.
	1951	Prune 30″ Pluck 36″	Skiff to level off Pluck 35″	Prune 27½″ and hand banjhi. Pluck 35½″	do
	1952	Prune 30½″ Pluck 36½″	Skiff to 35″ Pluck 37″	Skiff slightly if necessary. Puck 35½″	do
CYCLE 2	1953, 1954 & 1955	Repeat as above but all 1″ higher.	Repeat as above but all 1″ higher.	Repeat as above but all 1″ higher.	do

Yield of Tea:—The first treatments were applied in the cold weather of 1949-50 when plots were pruned at 27 inches. Analysis of crop yield for 1950 showed no significant difference between any treatments.

Analysis of 1951 crop yield, however, showed treatment 2 to be significantly better than any other ($P < 0.01$) with respect to total crop for that year.

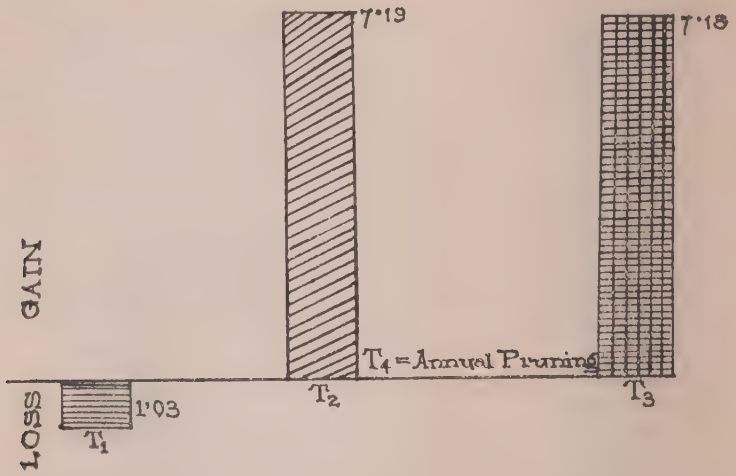
The yields for 1952 showed treatments 2 and 3 to be significantly better than treatments 1 and 4 ($P < 0.01$).

In 1953, *i.e.* in the 1st year of the second cycle, annual pruning (treatment 4) produced significantly higher yield than treatments 1 and 2 ($P < 0.05$). Tipping also commenced at a later date in all plots not annually pruned.

In 1954, *i.e.* in the 2nd year of the second cycle, the four treatments did not show any significant difference in yield.

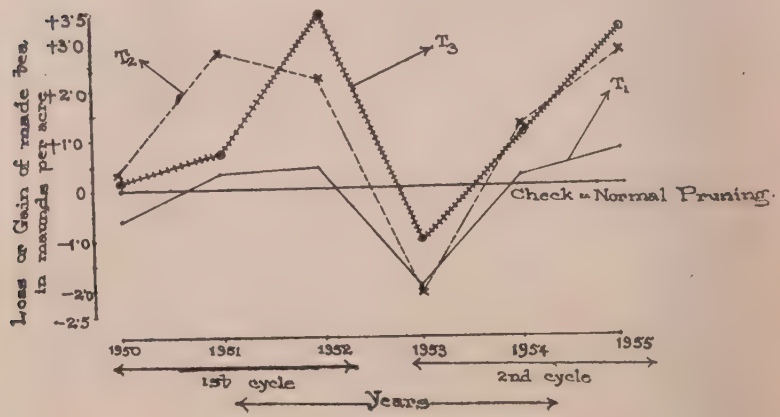
In 1955, which is the last year of the second cycle, treatment 3 gave significantly higher yields than treatments 1 and 4, whereas treatment 2 gave significantly higher yield than treatment 1. This result is more or less similar to the results obtained in the last year of the first cycle.

The gain or loss in maunds made tea per acre over the annual pruning at the end of the 2nd pruning cycle is shown in the following graph:—



It can be seen that both treatments 2 and 3, where one or two skiffs were introduced in each cycle, the yields are higher by 7.19 and 7.18 mds. per acre respectively over the period of 6 years.

The yearly differences over the annual prune are represented in the following graph:—



There is one interesting pointer here that treatment 1 where there is a very light prune, followed by an ordinary prune at $\frac{1}{2}''$ up, followed by a heavier prune at $\frac{1}{2}''$ above the 1st year level of the cycle, indicates a loss in crop over two cycles.

Pest infestations.—In 1953, *i.e.* in the 1st year of the 2nd cycle when treatments 1, 2 and 3 were pruned on to wood that was more than 1 year old, there was an infestation by jassids. With the co-operation of the Entomologist, observations were taken on the severity of attacks and it was found that the annually pruned plots (Treatment 4) were significantly ($P < 0.01$) least affected by jassids. The other treatments, where the pruning was done on wood that was more than 1 year old, did not show any difference between themselves and as such were all significantly more susceptible to jassids.

In 1955, observations were made on Red Spider infestations and it was found that the plots under treatment 3, which were slightly skiffed only, had the highest incidence of Red Spider. The pruned and deep skiffed plots did not show any serious infestations.

Cup characters.—With the co-operation and assistance of the Senior Biochemist samples of leaf were manufactured in each of the last three years.

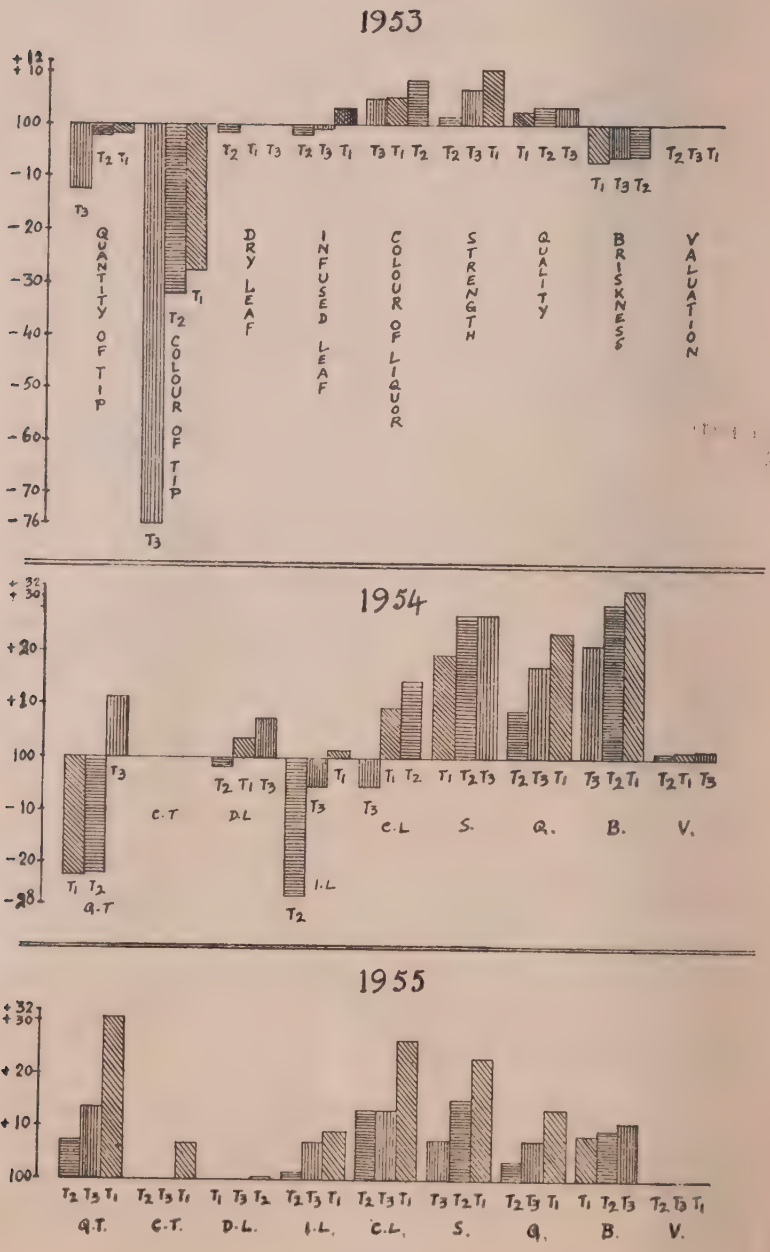
In 1953 representative samples of each plot were manufactured in a miniature scale after rolling the leaf in Pizey Rollers, and the samples were tasted by the Tocklai Taster.

In 1954 representative samples drawn from the bulked leaf of each of the four treatments were manufactured both by the normal and C.T.C. methods of manufacture in alternate weeks.

In 1955, representative samples drawn from the bulked leaf of each of the four treatments were manufactured by the normal method every fortnight.

In none of the three years the treatments have shown any significant differences in respect of quality of tip, colour of tip, dry leaf, colour of infused leaf, strength of liquor, quality, briskness and valuation. Only colour of liquor of treatment 1

PERCENT INCREASE OR DECREASE OVER NORMAL PRUNING i.e T_4.
$T_4 = 100$.



Results.—

Yield.

Method of Pruning.	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	Total	Yearly Average.
Annual December	11.21	11.82	11.92	16.17	16.84	18.33	10.74	13.26	11.05	13.24	10.13	10.93	11.36	167.15	12.86
	U P.		U. P.		U. P.		U. P.		U. P.		U. P.		U. P.		
Biennial October	11.94	12.12	10.64	15.84	16.33	17.20	9.76	13.24	10.42	13.47	11.15	11.77	10.79	164.17	12.67
Significant Difference reqd.	0.49	0.82	0.79	0 55	0.77	1.39	1.51	0.96	2.01	1.40	2.04	1.04	1.36		

U. P.—Unpruned.

showed up to be significantly better than treatment 4 in the third year of the 2nd cycle. This, however, did not make any difference in the valuation.

The graphs in page 50 show the trend of effect of the four treatments in each of the three years of the 2nd cycle.

Expt. B.5A : Annual December vs. Biennial October Prune.—

The tea in this experiment, which is a light leaf Assam jat, was planted in November 1932, at 4 feet square. There are eight replications of each of the two treatments, giving 16 plots, each of which consists of 96 bushes. The treatments were started in 1943, and are as follows:—

(*i*) Annually pruned plots were pruned $\frac{1}{2}''$ up in December each year, and tipping started as soon as 2 and a bud shoots appeared over the 8″ level of initial height.

(*ii*) Biennially pruned plots were pruned 1″ up in October every alternate year, and skiffed to level off in unpruned years in December. Tipping started as soon as 2 and a bud shoots appeared over the 8″ level of initial height in the pruned years, and as soon as possible after flushing started in the skiffed years.

In the years when the biennial plots are pruned, plucking of these plots must of necessity stop in October, whereas the annually pruned plots are plucked until December. On the other hand plucking of the biennially pruned plots always commences earlier than plucking of the annually pruned plots.

It may, therefore, be argued that the experiment fails to distinguish between pruning treatments and plucking treatments, but actually the plucking is consequent on the pruning, and hence crop yields do provide a legitimate basis for comparison of the two types of pruning.

It can be seen that in no years except in 1945, there has been any significant differences in yield. In 1945, the annually pruned plots gave significantly higher yield than the biennially pruned plots.

It is, however, true that the biennial October pruned plots produce significantly higher second flush yields and lower main

crop yield as will be seen from the table on page 51 giving mean yields for the last 10 years:—

Mean yield in mds. made tea per acre for the 10-year period (1946-1955).

Pruning system	Mean yield till end of June	Mean yield after end of June
Annual December prune	2.67	10.80
Biennial October prune	3.41	9.65
S. D. (P = .05)	0.59	0.60
% Loss or Gain due to Biennial pruning	+ 27.71	− 10.65

Cup Characters.—Leaf samples from all plots of each treatment were bulked separately and these were manufactured in 1954 and 1955 to assess the effect of the treatments on the cup characters of the made teas.

In cold weather 1953-54, both sets of treatments were pruned and hence all leaf plucked in 1954 were from pruned plots. The made teas were tasted by the Tocklai Taster and a panel of tasters in Calcutta.

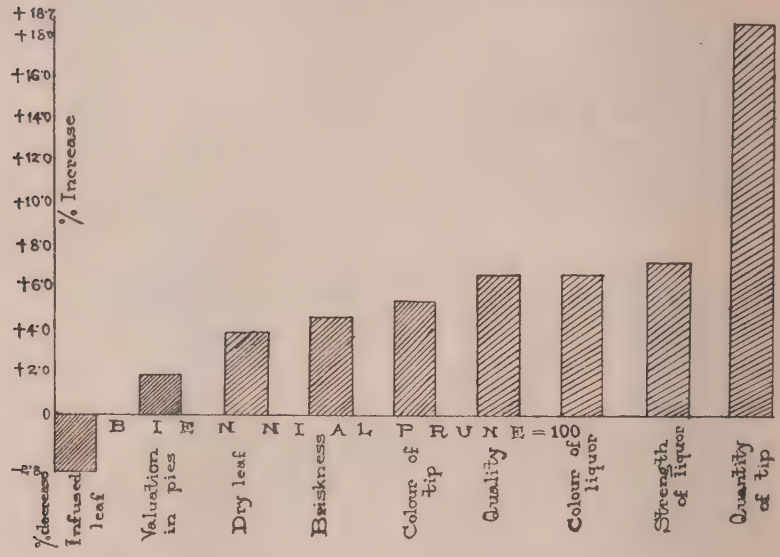
The Tocklai Taster did not find any significant differences in any of the attributes of the cup characters of the two lots of teas.

The panel of tasters in Calcutta, marked the samples from the biennially pruned plots in the pruned year to be significantly better than the teas from the annually pruned plots in respect of the colour of infused leaf, quality, strength of liquor, and briskness. It was, however, surprising to notice that inspite of the differences observed by them, they did not value the two samples to be significantly different.

In the cold weather 1954-55, the biennially pruned plots were left unpruned and the leaf from the two treatments were manufactured and tasted by our Tocklai Taster, and panels of tasters in Calcutta and London.

None of the tasters found any significant differences between the treatments in any of the attributes of the cup characters.

There was, however, a tendency to mark the samples from the annually pruned plots to be somewhat better in respect of most of the attributes by all the tasters. The following graph indicates the trend in percent increase or decrease, using the samples of teas made from the biennially pruned plots as check:—



Discussion.—It is often the case that unpruned tea suffers more from Red Spider, Black Rot, Thread Blight, etc. Indications have appeared in this area, that the Red Spider is more prevalent in the unpruned tea. Diseases, however, have not appeared badly, mainly because of the plots being small and clean pruning being done thoroughly in every pruned year.

Conclusion. –Though this experiment has so far failed to show any significant results, the following can be said to be applicable under the conditions of the experiment:—

(1) Biennial pruning does not significantly increase crop, although indications do appear in some years that yield may be slightly increased.

(2) The chances of Red Spider incidence are more in unpruned tea.

(3) The teas made from unpruned areas are likely to be poorer in their cup characters.

Expt. B.25 27: N.P.K. manuring of young Assam and China Tea Plants—

This multilevel N. P. K. experiment was started in 1954 on young Assam (Betjan) and China (Lingia) jat of tea. The treatments are three levels of nitrogen and four levels of phosphate and potash and their possible combinations. The levels are as follows:—

Nitrogen	*Phosphate*	*Potash*
0 lb.	0 lb.	0 lb.
40 lbs.	20 lbs.	20 lbs.
80 lbs.	40 lbs.	40 lbs.
	80 lbs.	80 lbs.

There are 48 different treatment combinations and 2 repeats.

1955 crop yield showed significant result only in the case of overall effect of nitrogen. Both 40 lbs. and 80 lbs. of nitrogen yielded significantly more than no nitrogen but there was no significant difference between the former two.

Overall Effect of Nitrogen

80 lbs.	40 lbs.	0 lb.
1.60	1.54	1.31

Difference required for significance at 5% level = 0.23

Expt. B. 11.2: N.P.K. manuring of mature Assam Tea.—

This multilevel N.P.K. experiment was started in 1954 on some 26 year old Assam jat of tea. Altogether there were 34 combinations of treatments—0 lb., 40 lbs. of nitrogen per acre in different combinations with 0 lb., 40 lbs. and 80 lbs. of phosphate and potash and 80 lbs. nitrogen with 0 lb., 20 lbs. 40 lbs. and 80 lbs. of phosphate and potash.

Results.—Both in 1954 and 1955 the effect of nitrogen is significant.

TABLE I

Yield in mds. per acre

	1954	1955
N_0	5.51	6.13
N_{40}	6.53	8.00
N_{80}	7.40	10.65
Significant Difference at 5% level	0.68	1.68

With the increased level of nitrogen, there is a proportionately significant increase in the yield. 40 lbs. and 80 lbs. of nitrogen increased the yield over no nitrogen by 18% and 34% respectively in 1954 and 30.5% and 73.7% in 1955. The trend is similar but in the second year *i.e.* in 1955 the absolute increment is much higher. Presumably this is due to cumulative indirect effect of manuring.

In 1954 the effect of phosphate and potash was not significant but in 1955, 80 lbs. P_2O_5 has yielded significantly more than no phosphate (by 7.9%). There is no difference between 0 lb. and 40 lbs. P_2O_5 or 40 lbs. and 80 lbs. P_2O_5.

TABLE II

Effect of Phosphate

Yield in mds. per acre

Year	P_0	P_{40}	P_{80}	S.D.
1954	6.36	6.46	6.62	0.38
1955	7.89	8.38	8.52	0.51*

* Significant at 5% level.

Interaction.—In 1954, NK and NPK interactions showed significant result. It was noticed that potash, especially in high concentration, tended to decrease the yield. This year although no interaction is significant, there appears to be a depressing

tendency from the high level of potash in presence of nitrogen and phosphate.

Cup Characters.—Leaf samples from plots receiving nitrogen only, nitrogen plus phosphate, nitrogen plus potash and nitrogen plus phosphate plus potash were bulked separately into 4 samples and were manufactured at Tocklai on six occasions between July and October. The made teas were then sent to the Tocklai Taster and panels of tasters in Calcutta and London.

No significant differences were observed in any of the treatments. This means that phosphate and potash have not affected the cup characters in any way.

Expt. B 8.2 : Effect of shade and manure :—

A. Yield of Tea.—In Area No. 8, Borbhetta, where four types of nitrogenous manures *i.e.* mustard oilcake, sulphate of ammonia, Calcium nitrate and Urea are being tried under three different light intensities *i.e.* 100% light, 70% light and 50% light, yield records are now available upto the fourth year.

In the 3rd and 4th year of the experiment there have been some very interesting differences from the result of the 2 previous years, both in responses to light and manures.

1. In the 3rd year, for the first time the gross effect of 50% light intensity provided by artificial shade failed to be significant over no shade. In the 4th year also this has been the case and actually there is an indication that it is depressing yield.

Yields in mds. per acre.

Light Intensity	1952	1953	1954	1955
100%	6.35	9.39	11.77	12.98
50%	8.18	11.19	12.57	12.18
S.D. required	1.62 (P= .01)	1.23 (P= .01)	1.38 (P= .05)	

2. The effects of 70% light *i.e.* the lighter shade also has been interesting. This light intensity maintained its

significantly higher yields till the 3rd year, but in the fourth year of the experiment, this also has failed to show any increases over no shade.

Yield in mds. per acre

Light Intensity	1952	1953	1954	1955
100%	6.35	9.39	11.77	12.98
70%	8.53	12.13	13.24	12.99
S.D. required	1.62 (P= .01)	1.23 (P= .01)	1.38 (P= .05)	

3. In the first year of application, the different forms of manures did not show any difference in effect.

   In the second year, only sulphate of ammonia produced significantly higher yields than Calcium nitrate and Urea, but it did not produce higher yields than oilcake, although oilcake itself did not produce higher yields than any of the other manures.

   In the third year, oilcake and sulphate of ammonia produced better results than Urea. The higher dose of Calcium nitrate also produced better yields than the higher dose of Urea.

   In the fourth year, oilcake produced better yields than Calcium nitrate and Urea, whereas both oilcake and sulphate of ammonia produced significantly higher yields than Urea. There was no significant difference in yields, between Calcium nitrate and Urea.

4. In the fourth year of the experiment, 150 lbs. of nitrogen as oilcake under full light has given the highest yield although not significantly higher than 150 lbs. of nitrogen as sulphate of ammonia under full light.

   150 lbs. nitrogen as oilcake produced significantly higher yields than 75 lbs. nitrogen both under 100% and 70% light, but 150 lbs. as sulphate of ammonia produced significantly higher yields than 75 lbs. nitrogen as sulphate of ammonia, only under 100% light.

With 75 lbs. nitrogen, highest yields were obtained with all four forms of nitrogen, only under 70% light.

With 150 lbs. nitrogen, highest yields were obtained under 100% light and the lowest yields under 50% light in the cases of oilcake and sulphate of ammonia, whereas in the cases of Calcium nitrate, the indications were that the yields were slightly higher under 70% light and in the case of Urea, under 50% light.

5. The overall effects of the four forms of manures in two levels have been that there are no significant differences in yields under the three light intensities, but the indications are that 100% and 70% lights produce the higher yields.

6. The following table shows the increases or decreases in mds. per acre due to the four manures in two doses under the three light intensities, over 75 lbs. of nitrogen as sulphate of ammonia in 100% light, which for this comparison has been taken as check.

Manure	Light	100%	70%	50%	MEAN	Cost of manures applied/acre
Oilcake	75 lbs	0	+0.73	−0.08	+0.22	Rs. 131 -4-0
	150 lbs.	+5.06*	+2.61*	+0.98	+2.88*	Rs. 262- 8-0
Sulphate of ammonia.	75 lbs.	CHECK	+1.14	+0.41	+0.52	Rs. 56- 1-0
	150 lbs.	+4.08*	+1,31	+0.25	+1.88*	Rs. 112- 2-0
Calcium Nitrate	75 lbs.	−0.65	+0.65	0	0	Rs. 65- 5-0
	150 lbs.	+1.22	+1.39	+0.98	+1.20	Rs. 130-10-0
UREA	75 lbs.	−0.49	+0.90	−0.49	−0.03	Rs. 54- 9-0
	150 lbs.	0	+0.57	+0.73	+0.43	Rs. 109- 2-0

Deviations over 1.81 are significant at 5% level.
* Significant deviations.

B. The Agricultural Analyst has estimated moisture, loss on ignition, pH and nitrogen content of soil and soluble and insoluble nitrogen fractions of plucked leaf of all treatments.

Soil Moisture.—Soil samples from all plots of this area were collected in December 1954 and in February 1955 to examine how the moisture in soil was conserved or removed under various manurial conditions and shade. At both times, it has been found that moisture content of soil in full light is significantly lower than under 75% and 50% light, there being no difference between 75% and 50% light. In the February collection while no significance was noticed between different manurial treatments and light x treatments in the December samples it was found that moisture in soil treated with 150 lbs. nitrogen as Urea was significantly higher than those in soils manured with 150 lbs. nitrogen as sulphate of ammonia, 75 lbs. or 150 lbs., nitrogen as oilcake 150 lbs. nitrogen as Calcium nitrate and Check. Moisture content of soils receiving 75 lbs. nitrogen or 150 lbs. nitrogen as sulphate of ammonia or 75 lbs. nitrogen as Urea was significantly higher than that of soils receiving 150 lbs. nitrogen as Calcium nitrate.

Nitrogen content of the Soil.—Soil samples were collected from this area in February before fresh manures were applied, to get an idea as to how the nitrogen status of the soil was maintained under different conditions of manure and shade.

Statistical analysis showed that light only produced significant effect. Nitrogen content of soil under 75% light was the highest and significant over those in soil under 50% light and full sun. There was no interaction between manure and light.

Soil Acidity as measured in terms of pH.- To see the effect of different nitrogenous manures applied to the soil on the acidity, a set of soil samples was collected in March and the pH determined. Light and light x manure had no effect on the pH. Sulphate of ammonia in low and high doses considerably increased the acidity of the soil as measured by pH and was significant over all other manures. Other forms of manure did not differ

amongst themselves significantly. Acidity was highest in soils treated with 150 lbs. nitrogen per acre as sulphate of ammonia, and lowest in soils treated with 150 lbs. nitrogen per acre as Calcium nitrate.

Organic Matter (*Loss on Ignition*).—One lot of samples of soil was collected in August and the organic matter contents, as given by loss on ignition were estimated. The following results were obtained.

Organic matter in soils under full light was highest but just missed significance. 150 lbs. nitrogen per acre in form of oil-cake produced significantly higher organic matter content of soil over all other forms of manure, there having been no difference between other forms of manure.

1954 and 1955 crop figures show that highest crops were obtained from plots manured with 150 lbs. nitrogen per acre as sulphate of ammonia and 150 lbs. per acre as oilcake (there being practically no difference between the two). This being so, the amount of pruning litter will be proportionately highest under these treatments. But the oilcake plots received in addition, organic matter in the form of the manure itself.

Soluble and Insoluble Nitrogen in Leaf.—Soluble and insoluble nitrogen in leaf were estimated in leaf samples from all plots collected in June, to see if application of different forms of nitrogen to the soil and varying light intensitites affected the two fractions of nitrogen in the leaf differently and have been expressed as percent dry weight.

Soluble Nitrogen.—Effects of light and dose were found to be significant. Soluble nitrogen in leaf from plots under 75% and 50% light was significantly higher than that in leaf under 100% light. There was no difference in nitrogen in leaf under 75% and 50% light.

Light	50%	75%	100%
Mean % soluble nitrogen ...	2.255	2.253	2.169

Significant Difference at 5% level = 0.067

Soluble nitrogen in leaf manured with the higher dose of nitrogen was significantly higher than in leaf manured with the lower dose.

Dose	150 lbs. per acre.	75 lbs. per acre
Mean % Soluble Nitrogen	2.251	2.200

Significant Difference at 5% level = 0.039

There was no significant difference between different forms of manure, nor were the interactions of manure with light and dose significant.

There was, however, an indication that soluble nitrogen was highest in leaf manured with Urea and lowest in leaf manured with oilcake.

Manure ...	Oilcake	$Ca(NO_3)_2$	S.O.A.	Urea
Mean % Soluble nitrogen ...	2.209	2.225	2.226	2.243

Insoluble Nitrogen.—Light had significant effect. Insoluble nitrogen in leaf from plots under 75% and 50% light was significantly higher than in leaf under 100% of light—there having been no difference between plots under 75% and 50% light.

Light	50%	75%	100%
Mean % Insoluble nitrogen	2.397	2.421	2.234

Significant Difference at 5% level = 0.061

Insoluble nitrogen in leaf manured with oilcake was significantly higher than in leaf manured with Calcium nitrate. There was no difference between other forms of manure.

Manure ...	Oilcake	Urea	S.O.A.	$Ca(NO_3)_2$
Mean % Insoluble Nitrogen ...	2.391	2.351	2.346	2.314

Significant Difference at 5% level = 0.060

The relationship of insoluble nitrogen between the two doses of applied nitrogen was irregular.

Expt. B.6.2 : Mechanical plucking—

One mechanical plucker is being tried out in an area of tea planted in 1935 at 4 ft. × 4 ft. square spacing. The mechanical plucker was compared with two other methods of hand plucking *i.e.* hand plucking in a weekly round and hand plucking in a somewhat longer round but plucked on the same days as the mechanical plucker. No definite plucking round was fixed for the mechanical plucker, but plucking was done with it whenever it was thought that there was sufficient leaf on the bushes to pluck. This usually was on an average a ten day round.

The plots are long plots of single row of tea containing 100 bushes each. There are three replicates.

Unfortunately the machine had to be modified several times by the Resident Engineer and it could be used properly since July on twelve occasions only. The results have been quite promising but need further trials. At the end of the season no difference in the health of the bushes was apparent.

Expt. B.29.4 : Closeness of planting -

The orthodox method of planting tea in North-East India has been to plant rectangular or triangular. The distance apart usually varies between 4 feet and 5 feet—the criteria being the maximum spread the bushes obtain at maturity at the normal plucking table. When planted in this manner, the number of bushes per acre varies between 1710 and 3140.

It was thought, however, that if a larger number of bushes per acre is planted by using closer spacing within the rows only, a much quicker ground coverage will be obtained and the tea will be brought into economic bearing much earlier, without impeding cultural operations. It was also thought that much higher yields per acre will be obtained. A better and earlier ground coverage means less expense on cultivation etc. as weeds do not grow profusely under tea that covers the ground adequately.

This type of closer planting, commonly known as " Hedge Planting ", would also eliminate the necessity of infilling after

the first 2 or 3 years from planting as the neighbouring bushes would easily fill up the vacant space. Amongst many other advantages, hedge planting would also facilitate the use of any future mechanical pluckers etc. The most common types of close or hedge plantings have been 5 ft. × 2 ft. and 5 ft. × $2\frac{1}{2}$ ft.

This experiment was designed primarily to ascertain the effects of four different distances apart of planting and to compare the merits of close planting with the orthodox method of square planting at 4 ft. × 4 ft. on one well known Assam jat of tea.

The following four treatments are being tried:—

(1) Distance apart of planting ... 4′ × 4 ′ square.
(2) ,, ,, ,, ,, ... 5′ × $2\frac{1}{2}$′ rectangular.
(3) ,, ,, ,, ,, ... 5′ × $2\frac{1}{2}$′ × $2\frac{1}{2}$′ rectangular.
(4) ,, ,, ,, ,, ... 4′ × 2 ′ rectangular.

The four treatments are randomised in three replicates.

Details of the Experiment.—The area of each plot is 0.02 acres.

The number of bushes per plot is as follows:—

4 ft. × 4 ft.	...	...	...	54 bushes
5 ft. × $2\frac{1}{2}$ ft.	...	...	...	70 ,,
5 ft. × $2\frac{1}{2}$ ft. × $2\frac{1}{2}$ ft.		...	...	84 ,,
4 ft. × 2 ft.	...	...	...	102 ,,

The number of bushes per acre being as follows:—

4 ft. × 4 ft.	...	...	...	2,700 bushes
5 ft. × $2\frac{1}{2}$ ft.	...	...	...	3,440 ,,
5 ft. × $2\frac{1}{2}$ ft. × $2\frac{1}{2}$ ft.		...	...	4,590 ,,
4 ft. × 2 ft.	...	...	...	5,460 ,,

Two year old seedlings of a light leaf Assam jat of tea were planted in April 1949, in Area No. 29 of Borbhetta.

Results:

Yields in maunds per acre.

Treatment	Year	1950	1951	1952	1953	1954	1955	Total
	Approx. No. of bushes per acre							
4′ × 4′	2700	0.70	3.52	11.77	8.02	13.97	11.20	49.18
5′ × 2½′	3440	1.41	3.80	11.77	8.44	13.41	11.16	49.99
5′ × 2½′ × 2½′	4590	1.50	4.50	12.70	8.34	14.58	11.11	52.73
4′ × 2′	5460	1.92	5.02	13.69	8.67	14.48	12.09	55.87
Difference required for significance at 5% level		0.86	N.S.	N.S.	N.S.	N.S.	N.S.	

N.S. means Differences not significant.

From the results of the last six years it is apparent that although in the early years there was an increase in yield from closer planting, the increase disappears in the later years. This also indicates that total yield does not vary proportionately with the number of bushes per acre. So it is safe to conclude that in close spacing the yield per plant is less than that in wider spacings. The following is a table showing the calculated yields per bush in pounds of green leaf per year:—

Yield per bush in pounds.

Spacing	No. of bushes per acre.	1952	1953	1954	1955
4′ × 4′	2700	1.55	1.055	1.839	1.475
5′ × 2½′	3440	1.20	0.857	1.362	1.123
5′ × 2½′ × 2½′	4590	1.08	0.706	1.234	0.941
4′ × 2′	5460	0.95	0.604	1.010	0.843
Significant Difference required at 5% level.		0.237	0.306	0.414	0.262

The above table shows that yields per bush is inversely proportional to the number of bushes per acre and have been significantly the highest with $4' \times 4'$ spacing, where the number of bushes per acre is lowest. It is also seen that on the whole the differences in the yields per bush of the treatments other than $4' \times 4'$ have not been significantly different since 1953 (except for $5' \times 2\frac{1}{2}'$ in 1955).

It, therefore, seems that we cannot increase the number of bushes per acre to the extent where the spread or the yielding capacity of the individual bushes is appreciably hampered—resulting in significant reduction in the yield of the individual bushes. (Please see our Quarterly Report, Vol. I, 1953).

It can, therefore, be surmised that with very vigorous bushes of a commercial jat or of a clone with large spreads, it is not likely to be an economical proposition to plant very close, particularly in good soils and suitable environmental condition. There appears to be a limit to the closeness of planting. Planting any closer than is entirely necessary is not likely to increase total crop.

Plants of vigorous jats and plantings in good soils of congenial localities can still be planted in hedges, but the distance apart must be directly proportional to their vigour and spreading capacity. Bushes of small spread and vigour when grown in poor soil, are likely to give the best return when planted in close hedges *e.g.* 4 ft. × 2 ft., whereas areas where bushes of exceptionally high vigour can be produced, are not likely to give any increased yield per acre if planted close. When these are planted in hedges, a much wider distance apart of the bushes in the hedges may have to be used.

Expt.: Observations on shade trees—

Observations on the health and growth of shade trees (Albizzia stipulata) under different manurial treatments were taken in three different areas at Borbhetta during the year 1955.

The object was to see the effect of various levels of phosphate and potash on the health and growth of Albizzia stipulata trees.

Growth was determined on the basis of height, as measured with an "Auto-Simplex" height recorder. Disease incidence (Die-back and Canker) were estimated by observers using the visual score method.

A. In Area 7, each plot receiving 18 different manurial treatments was planted up with one Albizzia stipulata tree in 1947.

The manurial treatments are the different combinations of the following:—

1. Nitrogen as sulphate of ammonia—40 lbs. and 120 lbs. per acre.
2. Phosphate (P_2O_5) as superphosphate—0 lb., 20 lbs & 60 lbs. per acre.
3. Potash (K_2O) as sulphate of potash—0 lb., 20 lbs. & 60 lbs. per acre.

Scores for health were given as follows:—

1.	Healthy tree, entirely free from disease ...	100 marks
2.	Slightly diseased	60 ,,
3.	Moderately diseased	40 ,,
4.	Severely diseased	20 ,,

Scores for Die-back were given as follows:—

1.	No die-back	0 mark.
2.	Slight die-back	2 marks.
3.	Moderate die-back	4 ,,
4.	Heavy die-back	6 ,,

Observations were taken on every tree in the experiment which has 8 replicates. The scores for each treatment were then summated according to treatments and the figures were statistically analysed. The observations on die-back were taken by two independent observers.

Results:

Height.

—	P_0	P_{20}	P_{60}	Total
K_0	247	253	271	771
K_{20}	277	237	284	798
K_{60}	216	298	288	802
...	740	788	843	...

Difference required for significance between the individual figures = 55 12 (P = ·05)

Health

—	P_0	P_{20}	P_{60}	Total
K_0	490	500	560	1550
K_{20}	600	470	540	1610
K_{60}	370	600	560	1530
...	1460	1570	1660	...

Difference required for significance between the individual figures – 143·26 (P = ·05)

It would appear from the above tables that 60 lbs. of potash without phosphate is detrimental for the health and growth of Albizzia stipulata. 60 lbs. of potash in presence of 20 lbs. of phosphate has, however, given the best result in cases of both height and growth. In the case of phosphate alone, although the difference is not statistically significant, there is an indication that it does produce benefit and this beneficial effect is increased with the increased level of phosphate and this trend is uniform and consistent. The overall effect of phosphate in three different proportions is also uniform and consistent both in the cases of height and health.

Observations on Die-back.—Many of the trees in this area showed symptoms of dying back from the top and observations on the severity of die-back under the different manurial treatments were taken at the same time by two independent observers. The phosphate and potash interaction tables are as follows:—

1st Observer

—	P_0	P_{20}	P_{60}	Total
K_0	44	34	48	126
K_{20}	54	48	44	146
K_{60}	62	36	46	144
Total	160	118	138	...

Not significant.

2nd Observer

—	P_0	P_{20}	P_{60}	Total
K_0	56	28	48	132
K_{20}	44	36	28	108
K_{60}	70	30	36	136
Total	170	94	112	...

Significant difference required for the totals of phosphate and potash ±39·98 (P ± ·05)

It is seen from the above tables that although the first observer did not see any significant differences in the trees under the different manurial treatments, the trend appeared to be the same to both observers. The trees receiving 60 lbs. of potash in the absence of phosphate have shown the severest die-back in both cases. This same treatment showed a depressing effect on health and growth (in height) of the shade trees in the previous observations. Phosphate has again shown a consistent and definite tendency to check the die back. Both observers noticed that 20 lbs. of phosphate alone produces the least amount of die-back. They both also noticed that the overall effect of 20 lbs. of phosphate per acre is good, but there is very little difference between 20 lbs. and 60 lbs. of phosphate.

B. Similar observations were taken by three observers in Area 5.

This area, which has a $2\times2\times2\times4$ factorial experiment with phosphate, potash, shade and nitrogen respectively, was planted up with Albizzia stipulata trees in 1942.

The phosphate and potash interaction tables are shown below:—

(1) *Mean height of trees in feet.*

	P_0	P_{45}	Mean
K_0	56	68	62
K_{45}	57	55	56
Mean	56.5	61.5	

(2) *Scores on Health.*

	P_0	P_{45}	Mean
K_0	760	1,000	880
K_{45}	880	700	790
Mean	820	850	

Phosphate and potash significant at 6% level.

P_0 = No phosphate.
P_{45} = 45 lbs. phosphate per acre.
K_0 = No potash.
K_{54} = 45 lbs. potash per acre.

The scores for health were given as in the experiment in Area 7, but with the addition that the dead (or infill) trees were given a 0 score.

Analysis of the health score figures showed the phosphate × potash interaction to be significant at 6% level. The only figure showing significant difference is that of phosphate alone ($P_{45}K_0$) which is better than the rest.

The same trend was noticeable on analysis of the height measurement, but these figures failed to show up to be significant. However, when the trends of both the tables are considered, it does indicate that phosphate alone is the most suitable manure for these shade trees.

C. In Area 40, another observation was taken on 64* Albizzia stipulata shade trees which have received different levels and proportions of phosphate and potash in four replicates. The trees were planted in 1941.

Health scores were given to these trees in the similar manner to those of the other experiments. The following is the phosphate and potash interaction table:—

	P_0	P_{15}	P_{30}	P_{60}	Mean
K_0	220	220	260	220	230
K_{15}	100	260	160	160	170
K_{30}	120	180	140	100	135
K_{60}	160	200	280	200	210
Mean	150	215	210	170	

P_0, P_{15}, P_{30} and P_{60} represent Nil, 15 lbs., 30 lbs. and 60 lbs. of phosphate per acre.

K_0, K_{15}, K_{30} and K_{60} represent Nil, 15 lbs., 30 lbs. and 60 lbs. of potash per acre.

The differences here are not significant but as in the other cases, phosphate alone shows the best result.

D. It may here be mentioned one 3 × 3 × 3 nitrogen, phosphate and potash experiment that was carried out by Mr. C. J. Harrison on newly planted young Albizzia stipulata trees using three levels of manure in each case.

The experiment was designed to confound the three factor interactions using three blocks of nine plots.

Detailed observations were taken during 1937 on girth, height, height of first branch, number of main and secondary branches etc. and girth observations were taken every year till 1942.

The following conclusions can be drawn from the results:—

Nitrogen — Small dose of nitrogen as sulphate of ammonia gave better results, but a heavier dose was significantly detrimental.

Phosphate— A heavy dose of phosphate as super-phosphate produced significantly better results.

Potash — No significant effect was obtained at any level.

General.—From the results of all these observations, it appears that phosphate (or superphosphate) has a beneficial effect on the growth of Albizzia stipulata trees, both young and old.

Expt.: Preservation of Bamboo Frames.—

An experiment was carried out to see whether chemical preservatives can give any protection to the bamboo frames commonly used in clonal nurseries, against decay so that a reasonably satisfactory service life could be obtained. These frames usually last about 2 years without preservatives. The laths were made from fresh bamboos and the treatments were applied to these prior to making the frames. Following are the eleven treatments including the check.

I. Creosote + old engine oil (50:50) + gammexane L.G. 140 (1:50).

II. Immersion for two months in water only.

III. Creosote and old engine oil (50:50) – (No gammexane).

IV. Check.

V. Boiling in 10% $CuSO_4$ solution for 10 minutes.

VI. Old engine oil only.

VII. Old engine oil + gammexane L.G. 140 (1:50).

VIII. Cuprinol.

IX. Copper napthenate + gammexane L.G. 140 (1:50) – applied by immersion.

X. Cuprinol + gammexane L.G. 140 (1:50).

XI. Copper napthenate.

N.B. –One part of copper napthenate (containing 10% Cu) was diluted in 5 parts of kerosene and laths dipped for 10 seconds only.

There were nine replications of each treatment, so altogether there were 99 frames. The laths were treated and frames made at the end of 1952 and since then they were always kept outdoor throughout the whole period and final observations were taken in November 1955 just after three years.

Minute observations were taken on the appearance, decay, wear and tear and general condition of the frames and depending on these the following four classificatiens were made:—

Classification	*Score*
Very good	1
Good	2
Bad	3
Very bad	4

Three observers took independent observations of all the 99 frames and the result was put to statistical analysis.

Result of observations :

	Total score of each treatment			
Treatment	*1st Observation*	*2nd Observation*	*3rd Observation*	*Total*
I ...	23	19	14	56
II ...	*36*	*33*	*28*	*97*
III ...	19	20	20	59
IV ...	33	30	25	88
V ...	*14*	*13*	*10*	*37*
VI ...	23	19	14	57
VII ...	25	20	17	62
VIII ...	28	21	18	67
IX ...	30	27	24	81
X ...	28	23	22	73
XI ...	30	26	27	83
Difference required for significance	6.55	5.50	5.94	

Significant at 1% level.

The above table indicates highly significant differences between the treatments. Although there was a little difference among the three observers, the general trend was remarkably similar. Each of them classified treatment V as the best and treatment II as the worst.

Further the treatments can be grouped into the following five different categories depending on their performances.

1. *Treatment V* — Boiling in copper sulphate 10% solution for 10 minutes. Each of the observers found it to be the best.
2. *Treatments I, III & VI* — Although these treatments showed promising result but as there was not much difference between them, it appears that old engine oil alone (VI) is as good as the other two.
3. *Treatments VII & VIII* — Their effect was just average.

4. *Treatments IX, X & XI* — Although these treatments showed significantly better results than Check (IV) and Treatment II, they were never as good as the treatments in categories 1, 2 and 3.

5. *Treatments II and IV* — These can be placed in the last group. It is interesting to note that Treatment II (immersion in water only for two months) is significantly inferior to Check.

The present condition of the frames treated with preservatives Nos. V, I, III and VI are quite satisfactory and should remain in usable state for about three more years. Frames under Treatment V look particularly good. Frames under other treatments are still usable except those treated by immersion in water only for two months and some of the check frames.

Observations were also taken of cuttings growing under the treated bamboo lath frames but no ill effect due to the use of preservatives was noticed.

From the results of this trial the following conclusions can be drawn:—

1. Boiling of the bamboo laths in 10% copper sulphate solution for 10 minutes gives the best result. This is also a very economical method and easy to apply. Frames treated with this remain in good condition and last longer.
2. Old engine oil which is a cheap waste product can also be profitably utilised.
3. Immersion in water for two months, failed to preserve the frames.
4. Use of gammexane with preservatives is not necessary under the conditions of the experiments.
5. Use of the prestrvatives tried in this experiment had no visible ill effect on the growth and development of cuttings.

PLANT PATHOLOGY BRANCH

ENTOMOLOGICAL SECTION

DR. G. M. DAS—*Senior Entomologist*

Staff.— The Senior Entomologist was on leave in the U.K. during the period April-September. While staying in London, he worked on identification of certain tea pests in the British Natural History Museum for two and a half months.

Mr. D. K. Dutt, Assistant Entomologist, resigned in December.

General.— Red Spider incidence was fairly high at Tocklai and in the neighbouring gardens during the early part of the season. It was reported as serious in the Dooars and Cachar at the end of the second quarter. Rim blight had been widespread following attacks of Jassids and Thrips in the Assam Valley and North Bank. The Longicorn borer, *Xystrocera festiva*, was reported to cause considerable damage to mature shade trees (*Albizzia* spp.) in the Dooars.

TRIAL AND EXPERIMENT

Root Borer (*Sternocera aurosignata*).—Two trials were carried out with Aldrin and Dieldrin as presowing treatment of nursery soil against the borer attacking *Albizzia odoratissima* and *A. procera* seedlings.

Julia Tea Estate

Treatments.—

A. Aldrin 40% W.P. @ 5 lbs. (2 lbs. actual) per acre.
B. Aldrex 24 E.C. @ 4/5 gallon (2 lbs. actual) per acre.
C. Dieldrin 50% W.P. @ 4 lbs. (2 lbs. actual) per acre.
D. Dieldrex 18 E.C. @ 1 gallon (2 lbs. actual) per acre.
E. Check (Untreated).

Each treatment with 4 replications.
Date of treatment—29-3-55.

Pertabghur Tea Estate

Treatments—

A. Aldrin 40% W.P. @ 5 lbs. (2 lbs. actual) per acre.
B. Dieldrin 50% W.P. @ 4 lbs. (2 lbs. actual) per acre.
C. Check (Untreated).

Each treatment with 6 replications.
Date of treatment—8-3-55.

Observation made in January, 1956, showed no external indication of damage on the seedlings both in treated and check plots. Further observations are therefore proposed some time in April, 1956.

Looper caterpillar.— Endrin 19.5% E.C. at two concentrations (1 in 800 and 1 in 1,600 parts of water) was tried out against full-grown Looper caterpillars under laboratory conditions. Results appeared to be satisfactory but as sufficient Looper caterpillars were not available for the trial, no definite conclusion could be drawn. It is, however, proposed to conduct field trials with Endrin as soon as opportunity arises.

Bark-eating Borers.—Bark-eating Borers are often reported to be quite prevalent in certain gardens. The present method of controlling these borers is to apply a few drops of used sump oil or Phenyle (1 in 10 parts of water) into the retreat hole by means of an oilcan, which however presents considerable difficulties in application.

In a small trial, retreat holes were plugged with a small amount of DDT 50% W.P. or BHC 5% dust after removing the web-runs. In the check the web-runs were also removed. Out of ten holes treated with BHC, nine holes remained closed for 15 days, while only one opened in the meantime. With DDT treatment, all the ten holes remained closed, whereas in the check new web-runs were made guarding the retreat holes. It appears that the plugging of retreat holes with DDT or BHC will be the most suitable method of control of these borers.

Tea Seed Bug.— Laboratory trials were carried out with Endrin, Malathion and Lindex at different concentrations. The

results indicate that Malathion 50% emulsifiable concentrate at 1 in 400 parts of water may be effective in controlling tea seed bugs, but field trials are necessary to corroborate the results obtained in the laboratory. Malathion Wettable Powder appears to be less effective than emulsifiable concentrate, whereas Endrin and Lindex emulsifiable concentrates are practically useless for controlling tea seed bug.

Agrilus beesoni.—A small trial was carried out to control *Agrilus beesoni* in the infested stems of young *Albizzia stipulata* and *A. odoratissima*, 3-4 year old, at Julia Tea Estate. Dieldrex 18 E.C. at 1 in 100 parts of water was applied to the affected stems with a brush. Observation made nine months after the treatment showed out of 15 treated plants 11 to be free from any infestation (showing signs of recovery from the damage) and 4 plants with slight infestation. In check (untreated) only 1 tree was free from infestation, the rest (14 trees) showed more or less persistence of attack.

From the results, it appears that it may be possible to save the young and nursery shade plants from the ravage of this insect by application of Dieldrex emulsifiable concentrate. Further trials are needed for confirmation of the results.

Association of ants with Coccids and Aphids on tea bushes.—Ants often make nests on tea bushes and it is almost invariably found that where there is a nest there is infestation either by Coccids or Aphids. The absence of any of the latter in the nest does not mean that there was none before. As is evident from the sooty mould growing on honey dew cover on leaves, shoots etc., the colonies had existed there but died out for some reason or other.

Ants occurring on tea bushes mostly live in association with certain scale insects and Mealy Bugs and Aphids. They derive honey dew secreted by these insects and afford protection to them against their natural enemies. It appears that the activities of these natural enemies are greatly increased where Coccids and Aphids are not attended by ants.

These ants do not always form their nests on tea bushes. They may have their nests on shade trees or in the ground.

Details are given in Tea Encyclopaedia Serial No. 112.

Coccids and Aphids associated with ants

Coccids or Aphids	Ants	Nests occurring on
(a) *Enclosed in the nest of ants*		
Coccus formicarii Green	(a) *Crematogaster dohrni* Mayr.	Tea bushes.
	(b) *Crematogaster* sp.	,, ,,
Saissetia discrepans Green	*Crematogaster* sp.	,, ,,
Coccus hesperidum Lin.	*Oecophylla smaragdina* Fabr.	Shade trees, tea seed baries, and occasionally on tea bushes.
Phenacoccus sp.	*Polyrhachis affinis* Sm.	Tea bushes and shade trees.
Toxoptera aurantii Boyer.	*Crematogaster* sp.	Tea bushes
(b) *Attended by ants*		
Saissetia nigra Nietn.	(a) *Pheidole sulcaticeps* Roger var *Punensis* For.	In the ground.
	(b) *Maranoplus* sp.	In the ground.
	(c) *Paratrechina* sp.	In the ground.
Eriochiton theæ Green.	*Oecophylla smaragdina* Fabr.	As stated above
Saissetia hemisphericum	*Technomyrmex modiili-anii* Em. *S. Sp. elatior* Forel.	In the ground.

A number of Coccids have been recorded as new pests of tea.

White Mite (*Acaphylla indiae* Keifer).—The mite was discovered by us as a new pest of tea in 1954. It has recently been described by Mr. H. H. Keifer of Department of Agriculture, California, as a new species from the specimens sent by Tocklai.

Pests of shade plants in nurseries .—The following is the summary of the incidence of insect pests on different shade plants, namely, *Albizzia lebbek, A. odoratissima, A. stipulata, A. procera, A. moluccana, Dalbergia assamica, Cassia laevigata, Leucaena glauca, Derris robusta, Adenanthera pavonina, Sesbania aegyptiaca,* as observed on a nursery at Tocklai.

Rhesala moestalis.—This insect occurred in a severe form on *A. procera* and *A. lebbek* while *A. stipulata, A. odoratissima* and *A. moluccana* were moderately attacked.

Psyllids.—A. procera and *A. lebbek* seedlings were severely damaged whereas *A. odoratissima* was slightly attacked.

A number of other insects were also found to occur occasionally on most of the species of shade trees but none was found to cause appreciable damage. Mention may be made of Leaf-eating beetles, Orange beetle, Membracids, Leaf-rollers, Jassids and Grasshoppers. A few coccids were noticed on *A. lebbek, Dalbergia assamica, A. odoratissima* and *A. stipulata.*

The number of insects occurring on *A. procera, A. odoratissima, Derris robusta* and *Dalbergia assamica* was recorded to be more than that occurring on any other shade. *Adenanthera pavonina* was practically free from insect damage.

Red Spider.— (*Oligonychus bioculatus W.M.*)—The Tea Red Spider has been placed recently in the genus *Oligonychus* (vide Rev. App. Ent. 'A' No. I, Jan. 1956).

A number of new acaricides were tried out in the laboratory against various stages of Red Spider. In all laboratory trials, one infested shoot represented one replicate, with 5 replications for each treatment. The size of the sample being often small and variation between the samples being large, the figures have been transformed into angles for statistical analyses. The transformed as well as the actual values are given in the table.

A. *Effect on eggs of Red Spider*

TABLE 1

Treatments	% eggs unhatched transformed into angles	Actual % unhatched eggs.
	(Mean of 5 replications)	
HRS 887 at 1 lb. to 40 gals. water (Boots Pure Drug) ...	21.64	15.90
HRS 942 at 1 in 2000 parts water (Boots Pure Drug) ...	17.36	9.34
HRS 942 at 1 in 1000 parts water	16.30	10.46
HRS 830 at 1 lb. in 40 gals. water (Boots Pure Drug) ...	14.97	6.94
Check	8.26	3.44

Treatments are not significant.

The ovicidal action of none of these materials was significantly superior to check.

TABLE 2

Treatments	% eggs unhatched transformed into angles	Actual % unhatched eggs.
	(Mean of 5 replications)	
Malathion 50% E.C. at 1 in 400 parts water (B. P. Mills) ...	86.37	99.00
Malathion 20% W.P. at 1 lb. in 20 gals. water (Boots Pure Drug)	81.48	95.92
Malathion 50% E.C. at 1 in 400 parts water (Plant Protection)	72.16	88.98
Tedion V-18 at 1 lb. in 100 gals. water (Philips—Roxane) ...	64.92	79.14
Supona at 2½ pints in 100 gals. water (Burmah Shell) ...	57.71	70.60
Check	10.14	3.18
Critical difference at 5% level ...	12.57	

Malathion as a wettable powder or an emulsion was found to be highly effective against eggs of Red Spider. Tedion V-18 and Supona were also considerably effective, but inferior to Malathion.

TABLE 3

Treatments	% eggs unhatched, transformed into angles.	Actual % unhatched eggs.
	(Mean of 5 replications)	
Malathion 20% W.P. at 1 lb. in 20 gals. water	81.00	96.94
Malathion 50% E.C. at 1 in 400 parts water (B. P. Mills) ...	80.82	96.64
Tedion V-18 at 1 lb. to 32 gals. water	69.92	87.50
Malathion 50% E.C. at 1 in 400 parts water (P. P.) ...	69.43	86.96
Check	9.66	3.70
Critical difference at 5% level ...	8.64	

This confirms the results obtained in the above trial. One of the proprietary formulations of Malathion E.C. however proved to be slightly inferior to others in its ovicidal action but was as good as Tedion V-18.

TABLE 4

Treatments	% eggs unhatched transformed into angles.	Actual % unhatched eggs.
	(Mean of 5 replications)	
Malathion 50% E.C. at 1 in 400 parts water (P. P.) ...	59.93	74.12
Supona at 2½ pints per 100 gals. water	44.46	49.20
Solbar at 1 lb. in 5 gals. water (Farbenfabriken Bayer) ...	42.91	46.40
Standard Lime sulphur at 1 in 40 parts water	26.84	20.56
Ovotran Y.F. 3799 at 1 lb. to 25 gals. water (I.C.I.) ...	18.27	10.88
Check	14.17	6.16
Critical difference at 5% level ...	8.86	

This also confirms the results of table No. 2 that Malathion is superior to Supona and Solbar. Lime sulphur affected a small percentage of eggs but Ovotran Y.F. 3,799 did not give better results than check.

TABLE 5

Treatments	% eggs unhatched, transformed into angles.	Actual % unhatched eggs.
	(Mean of 5 replications)	
Fisons acaricide CP/36/55 at 1 lb. in 100 gals. water (Atlas Fertilisers)	64.70	80.20
Tedion V-18 at 1 lb. to 32 gals. water	64.51	80.68
Supona at 2½ pints per 100 gals. water	51.17	60.68
Ovotran Y. F. 3799 at 1 lb. in 50 gals. water	24.90	17.74
Check	8.42	2.72
Critical difference at 5% level ...	6.50	

Fisons acaricide proved to be equally effective as Tedion V-18 in its ovicidal action. Supona also gave effective kill of eggs but was inferior to both Fisons acaricide and Tedion V-18, whereas only a small percentage of eggs were killed by Ovotran Y.F. 3,799.

B. *Persistent action on freshly hatched larvae*

TABLE 1

Treatments.	% larvae killed, transformed into angles.	Actual % larvae killed.
	(Mean of 5 replications)	
HRS 942 at 1 in 1000 parts water	9.70	4.94
HRS 942 at 1 in 2000 parts water	7.56	2.86
HRS 830 at 1 lb. in 40 gals. water	7.46	2.88
HRS 887 at 1 lb. in 40 gals. water	4.81	1.74
Check	0.00	0.00

Treatments are not significant.

The persistent action of these materials on freshly hatched larvae was negligible.

TABLE 2

Treatments.	% larvae killed, transformed into angles.	Actual % larvae killed.
	(Mean of 5 replications)	
Standard Lime sulphur at 1 in 40 parts water	69.84	84.86
Solbar at 1 lb. in 5 gals. water ...	67.82	84.40
Malathion 50% E.C. at 1 in 400 parts water (P. P.) ...	56.58	68.70
Supona at 2½ pints per 100 gals. water	46.11	51.86
Ovotran Y.F. 3799 at 1 lb. in 25 gals. water	1.45	0.32
Check	0.00	0.00
Critical difference at 5% level ...	10.20	

Lime sulphur and Solbar were significantly superior to others in their persistent action on freshly hatched larvae. Malathion and Supona were moderately effective but Ovotran Y.F. 3799 was not better than check.

TABLE 3

Treatments.	% larvae killed, transformed into angles.	Actual % larvae killed.
	(Mean of 5 replications)	
Solbar at 1 lb. to 5 gals. water ...	64.05	78.94
Standard Lime sulphur at 1 in 40 parts water	59.60	73.64
Supona at 2½ pints per 100 gals. water	58.07	70.60
Malathion 50% E.C. at 1 in 400 parts water (P. P.) ...	54.10	64.96
Ovotran Y.F. 3799 at 1 lb. in 25 gals. water	15.69	10.52
Check	0.96	0.14
Critical difference at 5% level .	12.41	

Solbar, Lime sulphur, Supona and Malathion E.C. were equally effective in their persistent action on freshly hatched larvae.

C. *Effect on active forms by direct spray*

TABLE 1

Treatments.	% active forms killed, transformed into angles.	Actual % active forms killed.
	(Mean of 5 replications)	
Standard Lime sulphur at 1 in 40 parts water	85.70	99.06
Malathion 20% W. P. 3 gms. plus HRS 1327 (Boots Pure Drug) 0.3 gm. in 600 cc water ...	74.84	92.58
Malathion 50% E. C. (P. P.) at 1 in 400 parts water	72.83	89.92
Malathion 50% E. C. (P. P.) 1 cc plus Ovotran Y. F. 3799 2 gms. in 500 cc water	72.40	88.58
Solbar at 1 lb. in 5 gals. water ...	69.84	85.98
Supona 2½ pints per 100 gals. water	29.34	24.14
Check	5.02	1.34
Critical difference at 5% level ...	9.24	

Lime sulphur gave the highest kill of active forms whereas various formulations of Malathion and Solbar were also highly effective but Supona gave only a small percentage of kill.

TABLE 2

Treatments.	% active forms killed, transformed into angles.	Actual % active forms killed.
	(Mean of 5 replications)	
Solbar at 1 lb. in 5 gals. water ...	81.80	95.94
Malathion 50% E.C. (B. P. Mills) at 1 in 400 parts of water ...	81.37	94.56
Standard Lime sulphur at 1 in 40 parts water	76.37	92.44
Malathion 20% W.P. at 1 lb. in 20 gals. water	71.43	87.52
Malathion 50% E.C. (P. P.) at 1 in 400 parts water	70.74	85.74
Supona at 2½ pints per 100 gals. water	33.30	30.96
Check	1.71	0.44
Critical difference at 5% level ...	12.93	

Solbar, Malathion (E.C. & W.P.) and Lime sulphur, however, proved to be equally effective against active forms in this trial.

Effect of Akar 338 on eggs sprayed on different dates during incubation period.

Treatments.	% unhatched eggs transformed into angles.	Actual % unhatched eggs.
	(Mean of 5 replications)	
Sprayed with Akar at 1 in 500 parts water within 24 hrs. ...	54.09	65.54
—do— between 24 & 48 hrs. ...	51.68	61.12
—do— between 48 & 72 hrs. ...	49.54	57.76
—do— between 72 & 96 hrs. ...	29.72	24.62
Check	10.51	4.24
Critical difference at 5% level ...	8.51	

There was little difference in the ovicidal action of Akar 338 sprayed at different times within 72 hrs. during the incubation period, but the mortality of the eggs was considerably reduced when sprayed shortly before hatching.

Conclusion.—Malathion as W.P. and E.C. showed promising results against active stages and eggs of Red Spider in our laboratory trials. Its persistent action on freshly hatched larvae appeared to be quite high. Field trials are needed before further comments on its efficacy can be made.

It may be mentioned that results obtained with Ovotran Y.F. 3112 against eggs were far better than those obtained this year with another formulation of Ovotran viz., Y.F. 3799, which however did not taint the made tea.

Field trial.—A field trial was conducted at Tocklai to find out the relative efficacy of Aramite (Florida formulation), Akar 338 and Lime sulphur in controlling Red Spider.

The trial was statistically designed with 4 treatments each having 5 replications.

One row having 13 bushes represented one replicate for each treatment. The treatments were applied by means of Pressure Retaining Knapsack Sprayers using low volume nozzles.

Count of active stages and quiescents was made 2 weeks after application from 10 leaves plucked at random in each replicate.

The following table shows the result:—

Treatments	Red Spider population (Mean of 5 replications)	% reduction over check
Aramite 15W (Florida formulation) at 1 lb. to 50 gals. water ...	232.4	71.9
Akar 338 at 1 pint to 62½ gals. water	278.2	66.4
Standard Lime sulphur at 1 gal. to 40 gals. water ...	227.4	72.5
Check	828.4	—
Critical difference at 5% level ...	354.99	—

Aramite, Akar 338 and Lime sulphur were all highly effective against Red Spider, and there was no significant difference amongst them.

Tainting effect on made tea.— Chemicals applied immediately after plucking on 19-5-55.

Our Tea Taster's comments on the samples of made tea are appended below.

Treatments	Replication	Dt. of plucking 26-5 55. Comments	Total rain fall after treatment	Dt. of plucking 2-6-55. Comments	Total rain-fall after treatment
1. Endrin 19.5% E.C. 1 in 800 parts of water	1	...	3.11"	Coarse in cup	5.53"
	2	...	,,	...	,,
2. Purified Ovotran Y.F. 3799 1 in 50 gals. of water	1	...	,,	...	,,
	2	...	,,	...	,,
3. Akar 338, 1 in 500 parts of water	1	...	,,	Coarse in cup	,,
	2	...	,,	Coarse in cup	,,
4. Colloidal sulphur (Ialine) 1 in 400 parts of water	1	Tainted (Horribly)	,,	Coarse in cup	,,
	2	,,	,,	Coarse in cup	,,
5. Check (Untreated)	1	...	,,	...	,,
	2	...	,,	...	,,

Termite control.— *Tarajulie Trial—1955*: A replicated trial with Aldrex E.C., Sulphate of Ammonia, and Oilcake was conducted at Tarajulie Tea Estate. There were five replications for each treatment. Aldrex was applied as a spray to the soil around the collar followed by forking down but the manures were applied broadcast.

Treatments	Rate per acre	Average earth-runs per bush in January
Check (no manure) ...	—	1.51
Sulphate of ammonia ...	80 lbs. N	1.31
Oilcake	80 lbs. N	1.26
Aldrex	2 lbs. actual	0.14
Critical difference at 5% level	—	0.34

Aldrex was significantly superior to other treatments in reducing the activities of termites on tea bushes, whereas Sulphate of ammonia and Oilcake did not prove better than check.

Silcoorie Trial—1955.— Any disturbance of the soil in the way of forking after application of Aldrin and Dieldrin for controlling termites, might increase the risk of erosion in Teelas and steep slopes and to find out how far these insecticides are effective when applied broadcast mixed with fertilisers, a trial with five replications for each treatment was conducted at Silcoorie Tea Estate.

The rate of Aldrin and Dieldrin was however doubled in the broadcast application. As Aldrin is volatile, it was decided to apply the treatments immediately after the rains so that a certain amount of Aldrin might penetrate the soil.

Treatments	Average No. of earth runs per bush
Aldrin 40% W.P. @ 2 lbs. actual per acre as spray and forked into the soil	0.000
Aldrex 24 E.C. @ 2 lbs. actual per acre as spray and forked into the soil	0.000
Dieldrin 50% W.P. @ 2 lbs. actual per acre as spray and forked into the soil	0.000
Dieldrex 18 E.C. @ 2 lbs. actual per acre as spray and forked into the soil	0.000
Aldrin 5% dust @ 4 lbs. actual per acre mixed with Sulphate of ammonia as broadcast ...	0.004
Aldrin 5% dust @ 4 lbs. actual per acre mixed with Oilcake as broadcast	0.004
Dieldrin 1% dust @ 4 lbs. actual per acre mixed with Sulphate of ammonia as Broadcast ...	0.000
Dieldrin 1% dust @ 4 lbs. actual per acre mixed with Oilcake as broadcast	0.000
Check (Untreated)	0.534
Critical difference at 5% level	0.081

All the treatments except check were found to be equally effective, and there is no significant difference amongst them. It makes no difference whether Aldrin or Dieldrin is applied as a spray at 2 lbs. actual per acre followed by forking or applied broadcast at 4 lbs. actual per acre.

It will be worthwhile to see how far Aldrin and Dieldrin are effective when applied broadcast at the same rate (4 lbs. actual per acre) or at a reduced rate (2 lbs. actual per acre) during dry weather conditions.

Borokai Trial, 1955.— Another trial was conducted at Borokai with Aldrin and Dieldrin at the rate of 4 lbs. actual per acre mixed with fertilisers and applied broadcast for comparison with Aldrin at the rate of 2 lbs. actual per acre applied as a spray. There were four replications for each treatment.

Treatments	Average No. of earth runs per bush
Aldrex 24 E.C. @ 2 lbs. actual per acre ...	0.033
Aldrin 5% dust @ 4 lbs. actual per acre mixed with Sulphate of ammonia	0.078
Aldrin 5% dust @ 4 lbs. actual per acre mixed with Oilcake	0.025
Dieldrin 1% dust @ 4 lbs. actual per acre mixed with Sulphate of ammonia	0.050
Dieldrin 1% dust @ 4 lbs. actual per acre mixed with Oilcake	0.000
Check (Untreated)	0.058

Treatments are not significant.

The incidence of termite being low at the time of observations (Jan. 1956) there was no difference between the treatments and check. Recent observations made by the Senior Entomologist show that there is no fresh damage by the termite in the plots treated with Aldrin as a spray, or Aldrin and Dieldrin applied broadcast mixed with fertilisers, whereas in the untreated plots the branches are found to be badly riddled and a

large number of termites could be found in the hollows and cavities of the damaged branches. The damaged branches in the treated plots are however showing signs of recovery.

Naharani Trial, 1954.— Further observations were made this year in the trial carried out with Aldrin and Dieldrin in 1954 (vide Annual Report 1954, pp. 83-84).

Treatments	No. of earth runs per bush
Aldrin 50% W.P. @ 2 lbs. actual per acre ...	0.075
Aldrin 50% W.P. @ 4 lbs. actual per acre ...	0.045
Dieldrin 50% W.P. @ 2 lbs. actual per acre ...	0.055
Dieldrin 50% W.P. @ 4 lbs. actual per acre ...	0.038
Check	0.285
Critical difference at 5% level ...	0.085

The results show that even 20 months after the treatments of Aldrin and Dieldrin the incidence of termites was significantly low in the treated plots. Whether this was due to the destruction of termite colonies in the nests or by their persistent action is not known.

Tarajulie Large Scale Trial, 1955.— A large area, about 30 acres of termite infested tea, was treated with Aldrex 24 E.C. as a general control measure. Observations were taken at random at 20 places each with 100 bushes from the treated area and also similarly from an adjacent untreated area.

Treatments	Average earth runs per bush
Aldrex 24 E.C. (at 2 lbs. actual) per acre	0.025
Check	2.193

Aldrin (Aldrex E.C.) proved to be highly effective against termites.

Advisory.— 81 specimens of insect pests were examined and reported on.

308 letters and memoranda were issued in connection with pests of tea and ancillary crops.

49 samples of insecticides were received for test.

Publications :

Serial No. 71/1, under J. 3.—Red spider, Part II.

Serial No. 77/1, under J. 3.—Control of termites attacking live wood of tea.

Serial No. 106, under J. 3.—*Helopeltis theivora* Waterh. (Tea Helopeltis).

Serial No. 86/1, under I.4—Proprietary Insecticides, Fungicides, Selective Weed Killers and Preservatives (in co-operation with other officers).

MYCOLOGICAL SECTION

K. C. SARMAH, MYCOLOGIST

BACTERIOLOGY

Bacteriological tests of the Tocklai water supply were carried out twice a week throughout the year.

Results, as monthly averages, are given below:—

Months.	Untreated water. (Tank)		Treated water.		Remarks.
	Total bacteria per c. c.	Lactose fermenters per c. c.	Total bacteria per c. c.	Lactose fermenters per c. c.	
January ...	26	5	1	0	
February ...	28	12	0	0	
March ...	29	7	0	0	
April ...	108	9	1	0	
May ...	141	27	1	0	
June ...	68	36	0	0	
July ...	86	73	0	0	
August ...	104	48	5	3	
September ...	126	101	1	0	
October ...	166	99	1	0	
November ...	88	37	1	0	
December ...	35	5	1	0	

In addition to the above 40 samples of water received from outside tea estates were tested for bacterial contamination.

MYCOLOGY

A record on the incidence of the important diseases of tea and shade trees has been built up from the reports of outbreaks and diseased specimens received from the estate Managers and

from the observations made by the Advisory Officers during their tours. The following table gives the places of occurrence by districts.

Diseases.	Districts.				Remarks.
	Assam Valley.	Cachar.	Dooars.	Darj. & Terai.	
Charcoal stump rot ...	13	1	7	—	Prevalent in all localities in the Dooars.
Brown root rot ...	9	—	6	—	
Other primary root rots	3	1	2	—	
Poria hypobrunnea ...	12	2	4	—	
Nectria spp. ...	3	—	—	—	
Red rust (*Cephaleuros parasiticus*) ...	38	13	4	—	
Blister blight ...	22	3	1	—	
Black rot ...	31	12	2	—	

Blister blight (*Exobasidium vexans*).—Blister blight occurred mostly during the spring in Upper Assam and disappeared as usual by about the end of May. From June to October there was no report on the incidence of the disease except a negligible attack in one of the Dooars gardens in September. During the months of November and December slight attacks were reported from 2 Cachar gardens and 2 Upper Assam gardens. This however does not mean that it was not prevalent elsewhere during the early cold weather but the outbreaks were not so severe as to cause alarm.

Red rust (*Cephaleuros parasiticus*.)—The disease was reported to occur in a wide-spread manner in the Dooars and in the Cachar district not only on tea but also on many species of shade trees including all the *Albizzia* spp., *Derris robusta* and *Adanenthera pavonina*. According to the Cachar Advisory Officer all cases of infection were traceable to diseased Boga medeloa (*Tephrosia candida*). Fructifications were noticed as early as 30th March and continued to appear throughout the year although the peak period was observed to be from April to July. On the contrary in many gardens in the Assam Valley and in the Dooars, fructifications appeared much later in 1955 than the usual period.

At Tocklai *Gliricidia maculata* (*G. sepium*) was found to be an additional host of the alga. It was also found to a small extent on *Crotalaria anagyroides* in certain places in the Dooars.

Poria hypobrunnea.—This stem disease is usually prevalent in varying degrees in all the districts, on tea subjected to collar pruning, heavy pruning under weak conditions and damages to branches resulting from sun-scorch, falling of shade trees, labour and cattle trespass etc. Its occurrence however was more conspicuous and alarming during this year, in the Dooars district, especially where the tea was subjected to long periods of drought consecutively for the past two years. Most of the affected bushes were fairly old in age and deplete of reserves. In some estates in the Dooars it is more of a rule to pluck the tea till the day preceding pruning. Consequently old tea, which has a bigger frame to support and a bigger plucking area, gets very little chance of putting back any surplus food and the condition gets worse under adverse climatic influences and also following damages to the leaves by pests and diseases. As a result debilitated tea is incapable of standing a drastic operation like medium or heavy pruning. The disease on such tea extends more rapidly than on healthy tea.

In order to avoid heavy deaths in old tea due to attack of this disease following medium pruning it is imperative to allow the tea to build up its reserves by resting for about two months before the pruning operation.

Even on good, healthy tea, a certain amount of die back is bound to take place after medium pruning. If the tea is not properly desnagged during the season following medium pruning and the heavier cuts are not protected from weather by indopasting, *Poria hypobrunnea*, which initiates in the cuts, gradually extends down the stem. Since it is not a quick killer its effect does not become noticeable until a few years later when the affected branches die out. By this time the disease probably reaches the main stem and a few months later travels beyond the collar. The bush is then beyond repair.

Medium pruned tea should be protected especially from sun-scorch vide recommendations given in T.E. Serial No. 53/1

filed under G.1. Prevention and methods of control of *Poria hypobrunnea* are given in T.E. Serial No. 68 filed under I.4.

Eelworms.— A new species of eelworm causing root-knot of mature tea has been recorded for the first time in N. E. India, in a tea garden in Cachar. This eelworm has been identified by Loos (of Ceylon) as *Meloidogyne brevicauda*.

Black rot.— Prophylactic treatment at Dibru-Darrang Tea Estate.

The Manager of Dibru-Darrang Tea Estate carried out an experiment on the treatment of Black rot, during the prophylactic period, with 2 copper fungicides, viz., Perenox and Coppesan (modified). The sprays were used with and without a spreading agent. Details of the experiment are as follows:—

(1) 2 areas (Nos. 1 and 2) each containing $30 \times 15 = 450$ bushes, known to be affected by Black rot were selected.

(2) Each area was divided into 6 blocks of 3 plots each and 3 treatments including a control were randomised.

(3) The fungicides were sprayed as 0.25% suspensions, without the addition of a spreading agent in area No. 1. "Teepol" was used with the sprays in area No. 2.

(4) Two applications were made in May 1955, at an interval of 18 days.

(5) Assessment on the incidence of the disease was made, on 3 occasions between the 4th week of June and end of August, by giving points to individual bushes in the following way:—

0 for no infection

1 for slight infection

2 for moderate infection

3 for severe infection

Results of the observations are tabulated below.

Section No. 10, Area No. 1 (1st assessment, 23-6-55).

WITHOUT SPREADER.

Total degree of infection per 25 bushes.

Treatment	Block I	Block II	Block III	Block IV	Block V	Block VI	Total	Per cent reduction
A. Perenox	3	7	2	0	2	2	16	89.2
B. Coppesan	1	5	0	0	0	1	7	95.3
C. Control	32	31	27	17	15	26	148	

Analysis of variance.

V. due to	Sum of sqq.	D of F	M. squares
Block	177.166	5	
Treatment	2077.0	2	1038.5 * * *
Error	122.334	10	12.2334
Total	2376.500	17	

S. D=27.0

Section No. 10, Area No. 1 (3rd assessment, 31-8-55).

WITHOUT SPREADER.

Total degree of infection per 25 bushes.

Treatments	Block I	Block II	Block III	Block IV	Block V	Block VI	Total	Per cent reduction.
A. Perenox	38	39	25	18	20	19	159	43
B. Coppesan	32	39	25	12	13	22	143	48.4
C. Control	49	58	61	33	33	45	279	

Analysis of variance.

V. due to	Sum of sqq.	D of F	M. squares
Block	1479.611	5	
Treatment	1841.778	2	920.889 ***
Error	256.222	10	25.622
Total	3577.611	17	

S. D. = 39.0

In both the assessments there is no significant difference between treatments A and B. Treatments A and B have produced highly significant effect over control.

Section No. 10, Area No. 2 (1st assessment, 22-6-55).

WITH SPREADER.

Total degree of infection per 25 bushes.

Treatments.	Block I	Block II	Block III	Block IV	Block V	Block VI	Total	Per cent reduction
1. Perenox plus spreader	1	5	4	0	1	1	12	88.8
2. Coppesan plus spreader	0	0	0	4	1	0	5	95.3
3. Control	10	12	20	13	33	19	107	

Analysis of variance.

V. due to	Sum of sqq.	D of F	M. squares
Block	112.444	5	
Treatment	1082 111	2	541.055***
Error	275.223	10	27.5223
Total	1469.778	17	

S.D. = 40.5

Section No. 10, Area No. 2 (3rd assessment, 31.8.55).

WITH SPREADER.

Total degree of infection per 25 bushes.

Treatments.	Block I	Block II	Block III	Block IV	Block V	Block VI	Total	Per cent reduction
1. Perenox plus spreader	21	23	18	18	25	23	128	47.1
2. Coppesan plus spreader	14	6	16	21	24	18	99	59.1
3. Control	31	39	52	24	51	45	242	

Analysis of variance.

V. due to	Sum of sqq.	D of F	M. squares
Block	360.277	5	
Treatment	1904.777	2	952.389 ***
Error	503.890	10	50.389
Total	2768.944	17	

S.D. = 55.0

In both the assessments there is no significant difference between treatments 1 and 2. Treatments 1 and 2 have produced highly significant effect over control.

It is evident from the results that careful application of suitable copper fungicides, prophylactically during the period recommended in the T. E. Serial on Black rot—No. 8/2 filed under I. 3, can reduce the incidence of the disease by about 50% even at the end of August, when the intensity of the infection would normally be at its height.

About 90% reduction could be effected during the peak period of flushing, with the consequence that loss in crop due to the disease attack would probably be very small. This is corroborated by the findings of an estate in Golaghat where

however the spraying was not done under a statistically laid out experiment.

The Manager's keenness in conducting the experiment has been very much appreciated.

Red rust—Winter treatment.— A mercurised copper oxychloride fungicide was applied during the winter season on young tea at Hattichungi Tea Estate. This tea was known to be affected in the preceding season by Red rust. Two applications were made in January, at an interval of 3 weeks, using the fungicide at two concentrations, 0.3% and 0.6% ; the former was the recommended strength. There were 6 blocks of 150 bushes each under 3 treatments *i.e.*, 6×50 bushes in each treatment.

Assessment of the disease made during the peak period of its fructification (*i.e.*, middle of June) showed no difference between the treated and the control plots.

Mercurised copper oxychloride spraying was not effective in controlling Red rust, when applied in the winter even at double the recommended strength.

Prophylactic treatment.— Spraying treatments were applied to young tea, at Hattichungi and Duklingia Tea Estates, on 2 occasions, once in the last week of April and again in the 3rd week of May. 10 treatments, including 2 concentrations of Mercurised copper oxychloride, were randomised in 6 blocks of 300 bushes each at Duklingia and another 6 blocks of 150 bushes each at Hattichungi. Leaf from the plots treated with Mercurised copper was not manufactured.

Observations made, in the 3rd week of June, on the intensity of the disease showed that the attack was very low in all the plots including the controls. There was no appreciable difference either between the plots treated with different fungicides or between the treated and the control plots. This was probably due to the fact that the fructifications of the alga were very late in appearing, in the Assam Valley, due to climatic changes.

Sclerotiniaceae.—Two fungi, *viz.*, *Botryotinia theae*, Hainsworth and *Ciboria theae*, Hainsworth, belonging to the *Sclerotiniaceae* family have been found to occur on tea flowers in most of the seed baries in N. E. India and the non-setting of tea seeds was analogically attributed in the past to the action of these two fungi. Some trials with the application of several fungicides, as sprays, during the flowering season were made in 1948-49 but the results were not conclusive. This year some more trials, strictly of a practical nature, were taken up in 2 tea seed estates. These trials were designed to test out control measures suggesting themselves as a result of study of the literature on *Sclerotinia* elsewhere.

A special fungicide (Tetra-methyl thiram disulphide, commercially known as 'Fernide') was supplied for use against these fungi by Messrs. I. C. I. at the suggestion of Mr. Hainsworth, the late Plant Pathologist of Tocklai.

In one of the seed gardens, under the Badlipar Tea Co., Ltd., at Golaghat, 9 treatments were applied in 3 blocks of 9 plots each. Each plot consists of 12 trees (3 rows of 4). The blocks were separated by drains and the plots by small nullahs.

The seed-bari was hoed and cleaned as a garden routine practice in the beginning of October 1955. After this 2 spraying treatments were applied on 4 occasions during November—mid-December ; 4 ground treatments with a liquid copper fungicide, two mercury fungicides and one copper dust at monthly intervals from October—December ; 3 controls—one against spraying, one against ground treatments and the 3rd against cultural operations.

A sceond large scale spraying experiment was designed by the Senior Advisory Officer, at Dhelakhat Tea Estate in Upper Assam. 6 plots of 280 trees each (about 2.07 acres) were marked out and 3 alternate ones sprayed with 0.25% 'Fernide' to which Teepol 710 was added as a spreading agent at the rate of 2 ozs. per 100 gallons. Altogether 4 applications were made at 10-12 days intervals, between mid-November and late December.

Results will be assessed by collection and weighment of the seed from the plots separately in 1956.

We are very thankful to the managements for giving us all facilities to carry out the trials.

At Tocklai, flowers of 6 different clones of tea were pollinated with pollens obtained from 2 different sources and then inoculated with *Botrytis* conidia, of one of the above named fungi (*Botryotinia theae*), produced in culture. The trials consist of 3 treatments in each clone. Fully developed flower buds which were about to open were selected for the purpose. The object of these inoculations is to test whether *Botrytis* conidia are responsible for infection of flowers resulting in non-setting of seeds.

So far our attempts to induce the fungus to produce its apothecial stage in culture have not met with success.

Primary root rots.—A new fungicide (3.5 dimethyltetra hydro—1, 3, 5, 2H—thiadiazine—2 thione, commercially known as "Crag 974") was recommended by the manufacturers for use as a soil treatment at 200-300 lbs. per acre against primary root rots in a Dooars tea garden. Since the fungicidal effect of the product was not known, trials in the laboratory as well as in the field were undertaken against the two commoner primary root diseases, *viz.*, *Ustulina zonata* (Charcoal stump rot) and *Fomes lamaoensis* (Brown root rot).

Preliminary laboratory trials have failed to show any effect on the fungi concerned. The work is being continued in the field at Tocklai.

Eelworm experiment at Koomtai Tea Estate.— In continuation of the experiment carried out with Shell D-D Soil Fumigant at Tocklai in 1954, further trials were taken up at Koomtai Tea Estate, Golaghat, for controlling eelworms in tea nurseries. Two substances *viz.*, Shell D-D and CBP-55, manufactured by Messrs. Shell Chemical Corporation, were used.

An area 17′ × 100′ was selected and cultivated to a depth of 12″. This was divided into 6 blocks of 17′ × 15′ each

separated by drains of 2′ width and 1′ depth. Each block in its turn was divided into 3 plots of 5′ × 15′ each, with separating drains of 1′ width and 1′ depth. The whole area was separated from its neighbourhood by an enclosing drain 2′ wide and 1′ deep.

Soil samples for eelworm count were collected on 27-9-54 before treatment, on 24-11-54 and 6-7-55 after about one month and 8½ months of application of the treatments respectively. Eelworm estimations were made by Baermann's method. Results are given in Table 1.

TABLE 1.

Blocks	Shell D-D			CBP-55			Control		
	Before treatment	After 1 month of treatment	After 8½ months of treatment	Before treatment	After 1 month of treatment	After 8½ months of treatment	Before treatment	After one month	After 8½ months
I	4	3	31	3	10	36	6	14	45
II	21	2	40	16	9	108	22	19	42
III	14	4	84	22	16	56	14	14	118
IV	24	1	191	36	6	15	14	9	24
V	13	3	25	12	11	33	19	13	17
VI	20	1	17	23	13	35	21	12	43

Treatments.—1. Shell D-D was injected by an injector gun calibrated to inject 3 c.c. of liquid per stroke at a depth of 9″ below the surface of the soil. In each bed 75 strokes were applied at 1 ft. interval (staggered). This was equivalent to 300 lbs. of the fumigant per acre. Each of the beds was watered immediately after fumigation with 5 gallons of water and the surface pressed hard by beating.

2. 8½ gallons of 0.2% solution of CBP-55 emulsifier were poured in each bed with a watering can. This was followed by the application of 8½ gallons of water to facilitate penetration. The beds were then pressed by beating on the surface.

3. *Control*.—Watered with 5 gallons of water and pressed by beating the surface.

Treatments were applied in the 3rd week of October and the beds were raked after one month.

In each plot 200 Dulia Manipuri non-germinated seeds were sown 11 days after raking the soil. Thereafter normal garden practice for tea nursery was followed. The nursery beds were unshaded.

All seedlings in each bed were uprooted in the month of July and examined for eelworm infestation (for results see Tables II and III). Intensity of infestation was assessed by putting—

0 for no infection
1 for slight infection
2 for moderate infection
3 for severe infection

TABLE II

Block	Shell D-D		CBP-55		Control	
	Degree of infection	Total plants	Degree of infection	Total plants	Deg ree of infection	Total plants
I	80	97	83	106	86	103
II	116	131	90	89	123	114
III	45	139	55	108	94	97
IV	118	114	119	112	132	122
V	119	117	129	106	110	86
VI	135	116	126	100	131	94
Total	613	714	602	621	676	616
Infection per plant	.858		.969		1.097	
Infection taking control as hundred	78.2		88.3		100	

TABLE III

Treatment	Total No. of seed sown	No. of plants emerged		Av. root length in inches	Av. shoot length in inches	Unaffected plants	Affected plants		Plants likely to be useful		Plants condemned	
		Total	%				Light	Moderate to severe	Total	%	Total	%
Shell D-D	1200	714	59.5	5.0	5.3	133	539	37	677	94.8	37	5·2
CBP-55	1200	621	51.7	4.8	5.0	91	467	63	558	89.9	63	10.1
Control	1200	616	51.3	4.6	4.8	35	486	95	521	84.6	95	15.4

Conclusion.—1. The above nematocides when applied to nursery beds, under the conditions prevailing at Koomtai, prior to sowing, failed to materially reduce the amount of eelworm attack on the seedlings as compared with the amount of attack in the untreated beds.

2. Under the conditions of the experiment there is little to choose between the effectiveness of the two materials in respect of eelworm population.

3. The treatments exerted no appreciable effect on the growth of the resulting plants, as judged by the length of roots and stems. (Weight of the plants was not recorded as partial drying took place in transit).

4. There was no appreciable difference in weed growth on the treated and control plots.

5. There was no incidence of *Pythium* sp. on any of the plots so the fungicidal properties of CBP-55 could not be ascertained.

We are thankful to the Manager for his kind co-operation in conducting the trials.

Nectria sp.—In the Annual Report for 1954 it was stated that all the observations made in 1952-53, on the experiments carried out at Tippuk Tea Estate and at Tocklai with the Tippuk strain of *Nectria*, showed it to be a disease of weak bushes. The amount of infection and the extent of damage to the branches

depended on the store of reserves which mainly governed the health and vigour of the bushes and their recovery from pruning. Strong and healthy bushes were resistant to infection to a great extent and they were capable of throwing off the disease if they did become infected.

The experiment was continued after discussing the matter in some detail amongst the Senior Advisory Officer, Assam Valley and North Bank, the Scientific Officer of Jokai (Assam) Tea Co., Ltd., and the Mycologist, in the light of the above findings.

The area selected for the experiment was Eriabari No. 4 (at Tippuk Tea Estate) which was severely affected by *Nectria* before.

A block of 324 bushes was divided into two sectors of 144 bushes each separated by a guard line of 36 bushes. Each sector in its turn was divided into 12 plots, each plot consisting of $4 \times 3 = 12$ bushes.

The whole area was pruned early in the autumn of 1953 to induce early regrowth in the next spring.

One sector was manured with 80 lbs. of N as Sulphate of Ammonia per acre and was allowed 8″ of new growth to the tipping level. The other half was left unmanured and was skiffed after some 6″ of growth was made, the purpose of this skiff was to produce as near as possible what would have happened during a hail-storm.

Starting from March 1954 every month one plot from each sector (*i.e.*, manured unskiffed and unmanured skiffed) was treated as follows.

(1) Two branches on each bush were pruned at 26″ and inoculated with pure cultures of the Tippuk strain of *Nectria*. The inoculated stems were immediately covered with alkathene tubing.

(2) At the same time starch reserve in the roots of bushes was estimated by iodine method, taking the average of 4 roots dug up from four sides of the bush.

(3) After 48 hours of inoculation the cuts on 3 rows of bushes in each plot were treated with the following. The fourth row received no treatment.

(*a*) Murphy's Mercury Fungicide Compound 618 @ 1½ pints per 5 gallons.

(*b*) Shalimar Winter Wash 5% solution.

(*c*) Perenox 1 lb. in 20 gallons.

(*d*) Control.

The treatments were applied by removing the alkathene wrappings which were replaced after application. The purpose of these treatments was to compare their fungicidal value when used 48 hours after inoculation. (At present our recommendations are to apply protective treatments against *Nectria* infection in an area within the first 48 hours of hail damage, vide T.E. Serial No. 65/1 filed under 1.3).

The results have been tabulated below. Table No. 1 shows the average starch and die-back month by month.

TABLE I

Manured and Unskiffed Vs. Unmanured and skiffed

Months		Manured and Unskiffed		Unmanured and Skiffed	
		Starch	Die-back in inches	Starch	Die-back in inches
March	1954	75	5.7	65	4.75
April	„	85	6.3	90	4.6
May	„	70	4.0	70	7.9
June	„	70	5.7	90	5.9
July	„	85	5.1	50	4.15
August	„	80	2.6	45	1.7
September	„	75	0.3	60	4.5
October	„	95	0.4	70	3.2
November	„	90	4.3	90	0.9
December	„	85	5.3	85	0.9
January	1955	80	0.15	90	1.0
February	„	60	Nil	70	0.8
Total		950	39.85	875	40.3
Average of 12 months		79	3.32	73	3.36

Table No. II gives the amount of die-back month by month under each fungicidal treatment of the cuts, applied 48 hours after inoculation.

TABLE II

Figures in inches

Months	Murphy's Mercury		Shalimar Winter Wash		Perenox		Control	
	Manured and unskiffed	Unmanured and skiffed	Manured and unskiffed	Unmanured and skiffed	Manured and unskiffed.	Unmanured and skiffed	Manured and unskiffed	Unmanured and skiffed
March 1954 ...	3.3	2.0	7.3	7.0	6.3	3.3	6.0	6.7
April ...	3.3	4.0	14.3	5.0	3.7	5.0	4.0	4.5
May ...	3.3	9.0	5 3	5.0	1.3	13.3	6.0	4.5
June ...	4.0	2.7	4.0	3.7	7.0	7.4	8.0	9.7
July ...	4.5	3.3	1.7	6.3	9.0	5.3	5.3	1.7
August ..	2.7	Nil	2.4	Nil	4.5	1.5	1.0	5.3
September ...	1.0	2.0	Nil	6 0	0.3	5.7	Nil	4.3
October ...	Nil	Nil	Nil	9.0	0.1	Nil	1.5	4.0
November ...	4.0	Nil	Nil	3.3	3.3	0.3	10.0	Nil
December ...	4.0	2.7	1.3	1.0	4.0	Nil	12.0	Nil
January 1955 ...	Nil	0.3	0.3	0.3	Nil	2.7	0.3	0.7
February ...	Nil	2.3	Nil	1.0	Nil	Nil	Nil	Nil
Total of 12 months ...	30.1	28.3	36.6	47.6	39.5	44.5	54.1	41.4
Total of both manured and unmanured ...	58.4		84.2		84		95.5	
Average die-back per bush ...	2.43		3.5		3.5		4	

Table No. III shows the average starch and die-back when the figures are grouped into quarterly periods, based on the usual pruning period of October-December in most gardens.

TABLE III

Periods	Approximate starch	Die-back in inches
Jan.-March	... 75	2.1
Apr.-June	... 80	5.7
July-Sept.	... 65	3.1
Oct.-Dec.	... 85	2.5

The Scientific Officer's comments are reproduced below.

"It was generally noticed that the plots which were not manured and skiffed did not show any appreciable reduction in starch content.

The amount of die-back appeared to depend to a very large extent on the length of the branch which was cut, in the majority of cases the die-back continued down the stem and stopped at the first junction where the next branch developed. Fructification took about 3 months to develop in the rains and there was little or no sign of fructification during the cold weather.

From September to February there was little or no die-back but from March onwards the die-back considerably increased.

Fungicides were applied 48 hours after the inoculations the fungicides used were Murphy's Mercury Fungicide, Shalimar Winter Wash Oil, Perenox ; none of these fungicides were found effective after 48 hours.

Before pruning of the plots, this cold weather (1955) the tea looked very healthy although every bush except the guard line was inoculated, it therefore appears that the disease is a weak parasite which attacks unhealthy bushes and has little or no effect on healthy vigorously growing tea.

Branches of bushes inoculated in 1953 still show no further sign of die-back, in several instances the dead stems were removed by labour for firewood a year ago and new wood has developed where the branches were broken off.

This section Eriabari No. 4 which was so severely hit by hail, and was very severely attacked with *Nectria*, in which this experiment was conducted has now completely recovered and is now yielding 24 maunds an acre."

The section received the following cultural treatments during 1953-55.

	Pruning	Plucking	Manuring	Hoeing	Yield per acre
1953	Light	to 8″ measure	80 lbs. N as S.O.A.	Kurpied and cheel hoed	17.91 mds.
1954	„	100 lbs. N	„	„	22.0 mds.
1955	„	„	„	„	24.0 mds.

At Tocklai the area used for inoculation experiment during November 1952—October 1953 was kept under observation in order to see the effect of the disease on the inoculated bushes and its spread to the adjoining tea. No attempt was made to remove the die-back portions of stem from the affected bushes and no fungicidal application was ever applied. These bushes were subjected to the same cultural treatments as their neighbours.

Observations made at the end of 1955 showed no difference in respect of health and vigour between them and the adjacent uninoculated tea. In most cases the die-back portion has either been destroyed by white ants or broken off at the nearest junction with another branch. The disease has not been found to spread to the neighbouring tea which is quite healthy. It should be noted that the area has not been subjected to hail damage or any out of season pruning during the period of observation.

The foregoing observations confirm our previous findings that the Tippuk strain of *Nectria* sp., which was once considered to be a primary disease, is only a disease of weak bushes. In *Nectria* susceptible areas treatment of the tea after hail or any other damage according to T.E. Serial No. 65/1 filed under I.3 and maintenance of good health and vigour by proper cultural methods are sufficient to prevent damage. It has therefore been decided to discontinue the experiments until further necessity arises.

The experiment at Tippuk Tea Estate was conducted by the Scientific Officer of Jokai (Assam) Tea Co., Ltd., under his direct supervision. We appreciate very much the amount of valuable time and attention he has devoted from the very incep-

tion of the *Nectria* work which would not have been possible otherwise.

Advisory.— The following samples were received for examination from tea gardens in N. E. India and a few estates in E. Pakistan.

1.	Specimens of tea and shade plants for disease identification	538
2.	Soil samples for eelworm test	396
3.	Water samples for bacterial test	40
4.	Plant protection products for trial ...	8

517 advisory letters and memoranda (including 53 inter departmental memoranda) were issued in connection with the above samples.

Publication.—The following Tea Encyclopaedia Serials were published.

1. Serial No. 107 under J. 1.—How to send soil samples from proposed nursery sites.
2. Serial No. 109 under I. 4.—Rim blight or Marginal necrosis.
3. Serial No. 8/2 under I.3.—Black rot—revised.
* 4. Serial No. 42/2 under I.3.—Thread blight—revised.
* 5. Serial No. 70/1 under I.3.—Control of Primary Root Diseases of Tea—revised.
*6. Serial No. 86/1 under I.4—Proprietary Insecticides, Fungicides, Selective Weed Killers and Preservatives—revised.
7. Methods of Drawing Soil and Water Samples for examination—"TWO AND A BUD" Vol. II No. 2.
8. A paper on Tylose Formation in Tea—submitted for publication in The 'Indian Phytopathology'.

Touring.— 11 gardens were visited during the year in connection with disease control.

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*Revised in cooperation with other officers.

BIOCHEMICAL BRANCH

D. J. Wood—Senior Biochemist

N. B. Chanda—Assistant Biochemist

Advisory.— During the year 44 memoranda and advisory letters on technical subjects were issued.

FUNDAMENTAL RESEARCH

Chemical Changes in Withering.—Reference was made in the Annual Report for 1954 to measurements of caffeine content in the shoots of a clone when freshly plucked, after 24 hours storage and after 48 hours storage in a moist atmosphere. The actual figures for total soluble nitrogen, caffeine nitrogen, other nitrogen (by difference) and solid matter are tabulated below, and are expressed as percentages of the dry weight of the fresh shoots. "Other nitrogen" is almost entirely due to amino-acids and amides.

		Total Sol. N.	Caffeine N.	Other N.	Solid Matter
Initial content		1.78	1.10	0.68	23.01
Final content	24 hrs.	2.02	1.30	0.72	22.24
	48 hrs.	2.24	1.38	0.86	21.59
Change	24 hrs.	+ 0.24	+ 0.20	+ 0.04	− 0.77
	48 hrs.	+ 0.46	+ 0.28	+ 0.18	− 1.42
% Change	24 hrs.	+13.5%	+18.2%	+ 5.9%	− 3.35%
	48 hrs.	+25.8%	+25.4%	+26.5%	− 6.17%

During 1955 the effect of various factors on these chemical changes has been investigated. The factors were: temperature; illumination; degree of evaporation. The investigation was carried out on clonal leaf to minimise sampling error.

1. *Temperature.*—Shoots of clone 3/24 were maintained for 24 hours at three different temperatures: 100°F., room temperature (averaging 85°F.) and 30°F. The comparison was

made on six dates from the end of June to the middle of September. Results were as follows:

		Total Sol. N.	Caffeine N.	Other N.	Solid Matter
Initial content		1.865	1.070	0.795	23.527
Final content	100°	2.074	1.173	0.902	22.678
	85°	2.156	1.208	0.946	22.672
	30°	1.925	1.104	0.821	23.448
Change	100°	+ 0.209	+ 0.103	+ 0.107	− 0.849
	85°	+ 0.291	+ 0.138	+ 0.151	− 0.855
	30°	+ 0.060	+ 0.034	+ 0.026	− 0.078
%Change	100°	+11.2%	+ 9.6%	+13.4%	− 3.61%
	85°	+15.6%	+12.9%	+19.0%	− 3.63%
	30°	+ 3.2%	+ 3.1%	+ 3.3%	− 0.33%

The difference between the figures at 30° and the figures at the other two temperatures is highly significant in all cases, as would be expected. The difference between 100° and 85° is significant at the 5% level in the case of total soluble nitrogen and caffeine nitrogen and is not significant in the case of other nitrogen or solid matter. The fact that caffeine increases faster at 85°F. than at 100°F. would appear to indicate that the enzymes involved are sensitive to relatively low temperatures. The total respiratory changes, however, are almost identical at these two temperatures judging from the figures for solid matter.

2. *Illumination*.—Shoots of clone 16/10/8 were kept for 24 hours in (a) darkness and (b) normal daylight by day and artificial light by night. The comparison was made on five occasions, four being in April/May and one in September. Results were as follows:

		Total Sol. N.	Caffeine N.	Other N.	Solid Matter
Initial content		1.819	1.259	0.560	23.494
Final content	Dark	2.059	1.412	0.647	22.550
	Light	2.067	1.425	0.642	22.490
Change	Dark	+ 0.240	+ 0.153	+ 0.087	− 0.944
	Light	+ 0.247	+ 0.166	+ 0.082	− 1.044
%Change	Dark	+13.2%	+12.1%	+15.5%	− 4.01%
	Light	+13.6%	+13.2%	+14.6%	− 4.27%

The difference between the two treatments is in no case significant.

3. *Degree of Evaporation.*—Shoots of clone 1/3/14 were allowed to wither naturally overnight, spread at two different thicknesses to give (a) a high wither averaging 53.7%, (b) a low wither averaging 71.5%. The comparison was made on five occasions from the end of June to the middle of September. Results were as follows:

		Total Sol. N.	Caffeine N.	Other N.	Solid Matter
Initial content		1.684	1.196	0.488	22.892
Final content	High	1.949	1.350	0.599	21.960
	Low	1.946	1.359	0.587	22.004
Change	High	+ 0.265	+ 0.154	+ 0.111	− 0.932
	Low	+ 0.262	+ 0.163	+ 0.099	− 0.888
%Change	High	+15.7%	+12.9%	+22.7%	− 4.06%
	Low	+15.6%	+13.6%	+20.3%	− 3.88%

Differences between treatments are not significant.

Conclusion.—Temperature appears to have a definite effect on the magnitude of chemical changes occurring in plucked leaf. The findings require to be extended, particularly to cover temperatures intermediate between 30°F. and 85°F. Illumination is evidently not a critical factor, so that differences in illumination intensity are not likely to upset the results obtained when investigating other factors. The amount of moisture in the shoot might be expected, owing to mass action effects, to influence the rate of chemical change. However this argument does not necessarily hold good where enzyme systems are concerned, and over the range investigated the moisture level appears to have had no effect. It is intended to repeat this experiment at a greater difference of moisture content.

Rate of Moisture Loss During Withering.—Previous investigations on the rate of withering have dealt with the effect of external factors—speed, temperature and humidity of the air. Investigations have now been started into various factors associated with the leaf, and have included the effects of coarseness of plucking and of *banjiness*, and a comparison between various *jats* and clones.

1. *Coarseness of Plucking.*—Shoots of two leaves and a bud and of three leaves and a bud from two different sources were withered simultaneously in the withering tunnel over a period of 3 hours, and the percentage wither at the end of this time was recorded. The two sources of leaf were (1) the F_1 progeny of the "Japvo" mating scheme, (2) clone 3/46. The comparison was made on twenty occasions between the end of May and the middle of October. Average figures are as follows:

Source	Two Leavers and a Bud		Three Leaves and a Bud	
	Average weight of one shoot	% Wither	Average weight of one shoot	% Wither
Japvo F_1	0.88 gm.	68.6	1.22 gm.	70.0
Clone 3/46	1.07 gm.	61.3	1.65 gm.	63.8

The difference between the two styles of plucking is statistically significant but remarkably small. In the case of clone 3/46 which shows the greater difference, if the shoots of three leaves and a bud had been withered for an extra $12\frac{1}{2}$ minutes their percentage wither would have been the same (61.3%) as that of the two-and-a-bud shoots. This answers the criticism of some planters that tunnel withering of "coarse" leaf will be much slower than the figures quoted by Tocklai which are based on "fine" leaf.

A point to be noted is that the shoots of clone 3/46 wither much faster than the considerably smaller shoots of the Japvo F_1 progeny. However measurements on a large number of clones and jats show that this relation between shoot size and withering rate does not hold good as a general case. (See below under "Jat Differences").

2. *Banjiness.*—Shoots were divided into two categories—those in which the bud is greater than half the length of the first leaf, and those in which the bud is less than half the length of the first leaf. The latter category may be considered as verging towards *banjiness*. Both categories were withered simultaneously in the withering tunnel and the percentage wither recorded

at the end of 3 hours. The average of twenty determinations was as follows:

Bud more than half the first leaf in length		Bud less than half the first leaf in length.	
Average weight of one shoot	% Wither	Average weight of one shoot	% Wither
0.99 gm.	70.4	0.89 gm.	71.1

The difference in wither between the two categories is not significant. It is intended to repeat this experiment on two categories showing a greater visible difference than the two chosen in this case.

3. *Jat Differences.*—In 1937 Wight showed individual bushes to wither at different rates, and mention was made in the Annual Report for 1954 of a variation in the rate of withering between individual clones. Data have been collected during 1955 to show the degree of difference between selected clones and jats. From the results it is clear that on average some clones or jats are definitely fast witherers whereas others are slow witherers, but on isolated occasions this position may be reversed and a normally slow clone may wither at a greater rate than a normally fast clone. This is illustrated by the following figures for rate of loss in weight per hour in conditions simulating tunnel withering.

Clone	1-11-55	8-11-55	15-11-55
3/191	11.1%	10.0%	10.1%
14/5/18	8.4%	10.9%	6.7%

On each occasion that measurements have been made a leaf count has been taken, but it is not possible to explain either the average rate of withering or the weekly fluctuation in terms of shoot size, composition of the flush, percentage of banji shoots etc. The explanation may be anatomical, and it is intended to investigate, in collaboration with the Botanical Branch, factors such as the number of stomata per unit area of leaf and the thickness of the cuticle.

Moisture Distribution after Rapid Wither.— Shoots of three leaves and a bud, specially plucked from the Japvo F_1 plot, were withered (1) in 3 hours in the withering tunnel, (2) in 22 hours by a natural wither, the overall wither percentage being approximately the same. The moisture content of individual portions of the shoot was measured after withering in both cases. The comparison was made on ten occasions and the average moisture figures are given below. The tunnel wither averaged 67.8% and the natural wither 66.8%. "Lower stem" is that portion of the stem below the second leaf.

	Tunnel wither	Natural wither
Bud ...	62.6%	61.1%
First leaf ...	59.4%	60.5%
Second leaf ...	63.2%	63.9%
Third leaf ...	64.4%	65.4%
Upper stem ...	72.8%	71.7%
Lower stem ...	77.0%	75.3%

The figures show that, with this type of leaf, the rapid tunnel wither is not nearly as uneven as might be expected when compared with a natural wither. In fact the moisture figures for equivalent portions of the shoot vary by only about 1%, and this small variation is most unlikely to have any far-reaching effects on manufacture.

The Volatile Constituents of Tea.—Work under this heading has revealed a considerable complexity of constituents, particularly among the carbonyl compounds. The substituted hydrazones from one flavoury clone were separated into ten fractions on a column, and the majority of the fractions appeared still to be mixtures. Similar hydrazones prepared from a Darjeeling tea appeared to be less in number though still of considerable complexity. Search for suitable means of separating these mixtures has led mainly to negative results, although a method tried recently appears promising. From the same Darjeeling tea two crystalline dimedone derivatives of carbonyl compounds have been separated and purified; carbon and hydrogen analysis will be necessary to complete their characterisation.

An unexpected difficulty in investigating the volatile alcohols has arisen through the presence of ethyl alcohol as an impurity in the ether used for extraction. This has led to a predominance of ethyl ester among the mixture of esters isolated. A method for the removal of this alcohol is now being worked out.

MANUFACTURE

In addition to the experiment described below the staff of the Biochemical Branch have assisted in the trials comparing two models of continuous roller with conventional methods of manufacture (reported under the Engineering Branch) and have conducted the manufacture of leaf from three Brobhetta field experiments (reported under the Agricultural Branch). An experiment on maturing is still in progress and will be reported in the next Annual Report.

Rapid Wither after Leaf Storage.—The Annual Report for 1954 gave results of a comprehensive experiment under this heading, from which it was concluded that storage of leaf overnight in suitable conditions followed by a rapid wither in 3-4 hours, leaf for this operation being spread at $3\frac{1}{2}$ lb. per square yard, would result in a tea equal in all respects to that made following an optimum natural wither. The leaf for that experiment was plucked to the usual standard prevailing at Tocklai which consists largely of two-and-a-bud shoots.

During the Annual Conference held at Tocklai in December 1954 the criticism was levelled at this experiment and also at the projected use of withering tunnels that results obtained with such fine leaf would not be applicable to leaf of a coarser standard of plucking. Some delegates were of the opinion that the stem of a shoot consisting of three leaves and a bud could not possibly be adequately withered in three hours, and that the teas would suffer in consequence. The answer given by the Biochemist was that trials undertaken in 1953 showed that coarse leaf rapidly withered made a tea no worse than that from the same leaf withered naturally in spite of the fact that the stems in the former case were not fully withered and could be broken between the finger and thumb. However these trials were limited

in number and it was considered advisable, in view of the criticism, to carry out a further experiment in 1955.

For this experiment shoots consisting largely of three leaves and a bud were used. After mixing, the leaf was divided into two portions. One portion was withered naturally overnight in the outside leaf house; the other portion was first stored overnight on hessian trays at a thickness of 15 lb. per square yard and was then transferred to the prototype withering tunnel and withered to the same degree as the first portion (average time in tunnel 3 hours). The experiment was performed on twelve occasions from the 21st July to the 6th October, the average percentage wither being 69.6% both for the natural wither and for the tunnel wither. The two portions of withered leaf were manufactured identically and sorted to give a small number of grades, samples from which were distributed to Tasters under code numbers.

The remarks of the individual Tasters show no consistent preference for either tea in leaf or in liquor. Average valuations given by each Taster separately, together with the combined average, are as follows:

	Natural Wither	Tunnel Wither
Tocklai Taster	Rs. 2/8/5	Rs. 2/7/10
Calcutta Panel	Rs. 2/5/3	Rs. 2/5/3
London Panel	Rs. 2/12/9	Rs. 2/13/2
Average	Rs. 2/8/10	Rs. 2/8/9

The difference in valuations given by the Tocklai Taster is significant at the 5% level. Other differences are not significant. The conclusion is that fairly coarse leaf can be withered in the tunnel without detriment to its manufacturing characteristics. This conclusion is supported by the results of the Withering Tunnel experiment reported under the Engineering Branch, for which leaf from two commercial estates was used. The actual amount of moisture in the different parts of a three-and-a-bud shoot after a forced wither (3 hours) and after a natural wither (22 hours) is given in a different part of this report.

TEA TASTING SECTION

J. M. TRINICK—TEA TASTER

Staff.— Mr. A. K. Barooah unpaid tasting student rejoined the department in May and left at the close of the manufacturing season in December.

Tasting.— The Taster reported on some 12,000 samples of teas during the course of the year. These samples mainly consisted of Tocklai Experimental Manufacture, clones from Tocklai and outside estates and manufacturing trials carried out by estate managements.

The Tea Taster also regularly attended "Company Tasting" held at the Jorehaut Tea Company Ltd. and run by their Tea Taster, Mr. R. C. J. H. Gilchrist. A considerable number of teas were also brought to the Taster by Managers for verbal reports and advice.

Touring.—The following estates were visited during the year in connection with manufacture and tasting:—

Koomtai, Silcoorie, Burnie Braes, Lallamookh, Lallacherra, Borokai, Arcuttipore, Hunwal, Hoolungoorie, Heeleakah, Katonibari, Duklingia, Jaboka, Muttrapore, Suffry, Napuk, Cinnamara, Lukwah, Dhulapadung, Sessa, Ghoirallie, Borjuli, Sonajuli, Sangsua and Socklatinga Tea Estates.

Cachar Tour.— The Taster visited the Cachar district during the second quarter of the year and inspected six factories accompanied by the Cachar Advisory Officer. A report on this visit, dealing with tea manufacture, has been sent to the Cachar Advisory Branch.

Prototype Withering Tunnel Experiment.— Throughout most of the season tests were conducted weekly with the co-operation of the Manager, Katonibari T. E. and fortnightly with the co-operation of the Manager, Duklingia T.E. The Taster was closely connected with the carrying out of these experiments and he also reported on the resultant teas together with the Calcutta and London Panel of Tasters. Samples of both treat-

ments were tasted blind and on no occasion was the Taster able to state emphatically that the leaf had been withered either by the natural or artificial method. On the majority of occasions both sets of samples were extremely similar.

Continuous Rollers.— Throughout the year many samples have been seen by this Department from the Continuous Rollers being developed by the Engineering Section. As far as liquors are concerned there is no doubt that these rollers produce normal teas. The leaf appearance however does vary from the orthodox and it is difficult to decide whether this "New Look" will be appreciated by buyers. The matter will be further investigated during 1956 when the Taster hopes to have the opportunity of discussing this point with members of the Trade both in London and Calcutta.

Other Tocklai Manufacture.— Many samples of teas were tasted from other Branches in Tocklai other than the Engineering Department but as these teas were tasted blind it is impossible for any conclusion to be made by this Department.

ENGINEERING DEVELOPMENT BRANCH

I. McTear—Senior Research Engineer

During the period under review development has mainly concerned the following:—

(*i*) Controlled Withering.

(*ii*) Continuous Processing Rollers.

(*iii*) Mechanical Harvesting of leaf and Light pruning utilising the same vehicle.

Controlled Withering.— Apart from development work on the Tocklai Prototype Withering Tunnel a series of competitive tests have been conducted (Controlled wither versus Natural withering) over a full season in co-operation with (a) Katonibari Estate and (b) Duklingia Estate. The former employs C. T. C. manufacture and the latter conventional two-rolls manufacture thus providing valuable information on this much debated subject. Tea samples of each test have been submitted to three independent authorities (a) London Panel of Brokers (b) Calcutta Panel of Brokers and (c) Tocklai Taster who were unaware of the method of withering.

The procedure adopted in the case of Katonibari Estate (C.T.C.) entailed the weighment of two lots of 400 lbs. green leaf from leaf previously bulked, one portion spread for natural wither in the normal Chung structure and the other lot transported to Tocklai (6 miles) for treatment in the Withering Tunnel. The resulting withered leaf (70% wither*) in both cases being sufficient for 2×36″ dia. Rollers. This leaf was kept separate in all subsequent phases of manufacture when grade percentages were determined and finally samples were submitted to the three authorities mentioned.

Thirty competitive tests were carried out during the Season. The average percentage withers obtained were:—

(a) Tocklai Tunnel Wither 69.80%,
(b) Katonibari 73.60%.

*Note:—% wither is the weight of the withered leaf expressed as a percentage of the weight of the fresh leaf.

Although the Katonibari natural wither of 73.60% average may be considered adequate for C.T.C. manufacture such a figure is rarely obtainable on most Estates. It so happened that by unusual coincidence the weather conditions prevailing during this one-day-a-week test were very favourable for natural withers.

An analysis of the report received from Tasters indicates that there is no significant difference between the two methods of withering. Valuations received were as follows:—

	Tocklai Tunnel Wither	Katonibari Natural Wither
(i) London Panel of Tasters	Sh 4/5	Sh 4/5.1
(ii) Calcutta -do-	Rs. 2/11/10.2	Rs. 2/12/3
(iii) Tocklai Taster	Rs. 2/12/10.5	Rs. 2/12/9.6

Technical information recorded during these tests shows that the rate of evaporation of moisture from the leaf varied between 8.10% to 12.3% per hour which gave an average over the season of 10.50% per hour. The average dry bulb temperature of the air at the inlet to the leaf was 94.9°F which, with fluctuating atmospheric conditions, gave an average of 14.7°F hygrometric difference. Actual time in the Tunnel was approximately $2\frac{1}{2}$ hours for C.T.C. teas; balance moisture loss occurred as a result of leaf in transit, and handling losses; this, during the rains period, being 7-8%.

Similar procedure was adopted for conventional two Rolls manufacture except that the quantity of leaf handled was 1,600 lbs.; from this bulked leaf, 800 lbs. was allocated for natural wither and a similar quantity for controlled wither. The reason for this change was due to the larger size of Rollers used—46″ dia as opposed to 36″ dia for C.T.C. manufacture.

The average withers resulting over 12 tests were as follows:—

(a) Duklingia natural wither 64%, and

(b) Controlled withers 64%.

Natural withers varied between 51% maximum and 72% minimum. Controlled Tunnel withers were 62% maximum and 67.8% minimum.

The average temperature of the air inlet to the leaf during the rains period was 98.3°F dry bulb. From the beginning of November onwards the average dropped to 86°F dry bulb. This dry-bulb temperature is governed by the condition of the atmosphere prevailing during withering. The Tocklai Withering Tunnel operates at 14-15°F. hygrometric difference. When near-saturation of the atmosphere prevails heat is added to the incoming air to create this difference between the Dry and Wet bulb thermometers. As atmospheric conditions become more favourable for drying (*e.g.* during periods of sunshine) the artificially generated heat is reduced. During the rains period in Assam the atmosphere frequently provides 50% of the total drying properties required for withering in the Tunnel. Thus it operates under conditions very closely approximating to natural atmospheric conditions as it is possible to attain in a withering installation which achieves the desired degree of wither in $2\frac{1}{2}$-4 hours depending upon the percentage wither required.

These tests were commenced during the month of June and continued fortnightly until the close of the season at the end of November.

The average valuations resulting from these tests were as follows:—

	Tocklai Tunnel Wither	Duklingia Natural Wither
(i) London Panel of Tasters	Sh 4/7¼	Sh 4/6½
(ii) Calcutta -do-	Rs. 3/0/2.1	Rs. 2/15/9.8
(iii) Tocklai Taster	Rs. 2/15/5.7	Rs. 2/14/7.9

Although the benefits of controlled withering cannot be assessed to the full by tests such as these they have provided sufficient evidence to state that this method of withering is not in any way harmful to the leaf.

Brokers reports gave a very slight preference for briskness in the naturally withered teas. But make and tip content of the Tunnel Withered leaf were generally preferred. It may be that the conditions of lengthy transport of the leaf to Tocklai and subsequent return of the withered leaf to Duklingia would account for the slightly less briskness of the Tunnel Withered tea. As in the case of the Katonibari Estate natural wither, the average of 64% wither of Duklingia Estate over 12 tests is by no means representative of commercial standards of wither over a season's working since it was observed that the leaf spread in the Estate Chung structure did not generally follow normal standards of spreading. Leaf was spread over a greater area than is ever possible in practice whereas the Tunnel withers were in excess of the recommended rate of spread being 4.00 lbs. per square yard as against what is considered to be the optimum of 3.50 lbs. per square yard.

It is reasonable therefore to conclude that leaf withered under controlled conditions in the Tocklai Tunnel is in no way inferior to what may be termed ideal natural withers.

All the above competitive tests were conducted under exactly similar conditions as recommended for commercial units; the prototype being a scaled-down version of the large commercial units which can be designed to handle the following quantities of green leaf during 4 hourly periods:—

Green Leaf	Withered Leaf 65%	Made Tea/HR.
Size A-12,000 Lbs (150 mds).	7,800 Lbs (90.7 mds).	690 Lbs (8.6 mds).
Size B- 8,000 Lbs (100 mds).	5,200 Lbs (65 mds).	460 Lbs. (5.7 mds),
Size C- 4,000 Lbs (50 mds)	2,600 Lbs (32.5 mds).	230 Lbs. (2.8 mds).

Although leaf can be treated under controlled withering conditions in considerably less than 4 hours there is inevitably an uneveness in the wither which is quite unavoidable whatever the method employed. For the gross wither percentages obtained during the tests, which are the subject of this report, the period of treatment in the Tunnel has averaged 2½ hours for C.T.C. teas (70% wither) and 3 hours for conventional two-rolls

manufactures (64% wither). Any attempt to reduce the time still further is not considered to be beneficial.

The desirability of being able to process leaf which is withered to the requisite degree cannot be refuted. It is not just a question of better prices resulting from a product made under stable withering conditions: the effects are very far reaching, perhaps more so than generally appreciated.

The position arising from the limitations imposed by natural withering are most noticeably felt in the Rolling and Drying machines necessary to deal with a particular crop. There must be sufficient Rollers and Dryers to handle the crop when the leaf is 'Kutcha' into which category withers of 80% and even less have to be considered. If adequate machinery is not available then working hours must be increased. Consequently the through-put of any factory is solely determined by the ability to wither the leaf to a standard throughout the year. For example a 65% wither will enable a Roller charged with 650 lbs. of withered leaf to handle 230 lbs. of made tea per charge. But in the case of an 80% wither 650 lbs. of leaf will produce only 186 lbs. of made tea. Thus it takes 5 Rollers to handle 80% withered leaf compared with 4 machines for the 65% wither for an equal amount of made tea. From the cost angle this is 24% more capital outlay or alternatively 24% longer working hours.

Drying machinery is based on the ability of the machine to evaporate so many pounds of water per hour and the water content of the fermented leaf is entirely governed by the degree of wither obtained. Even given average natural wither conditions the degree of wither resulting from leaf spread in a number of structures, as commonly practiced, can vary to a considerable extent. This results in ever-changing conditions during drying.

In considering Drying machines the same argument holds as for Rolling machinery only more so. An 80% wither contains 35.7% more moisture than a 65% wither. Expressed in another way: for every 1000 lbs. of green leaf (at 23% solid content) withered to 80% there is an additional 150 lbs. of water

to be evaporated by the Dryer when compared with a 65% wither which implies that, other factors being equal, it requires rather more than 4 machines for the 80% wither compared with 3 machines of similar capacity for the 65% wither for the equivalent made tea output. This again in terms of capital outlay is 35.7% additional expenditure, or in the absence of extra dryers, 35.7% longer working hours. The above are some of the inescapable aspects associated with inadequate withering facilities. There are others too well known to require repetition.

Mechanical Harvesting of Tea.— This mechanically propelled machine arrived from the U.K. late 1954. Initial field tests were commenced during May 1955 and have continued together with machine development until the end of the plucking season. The machine operated over 9 rows of tea planted $4' \times 4'$ in competition with (a) Hand plucking on a 7 day round (b) Hand plucking at the same frequency as the machine operated. All three types of harvesting were located in the same area and were in fact adjacent rows of tea devoid of shade trees. The primary object of these trials was machine development since after the preliminary test it became clear that certain radical alterations were necessary as well as additional devices to enable harvested leaf to be mechanically cleared from the machine into a separate leaf container which of necessity must be above surrounding tea level.

Relocation of the drive gear for the cropping mechanism was attended to and a new set of cutting knives of greater cutting capacity were made and fitted. By utilising a relay rotary paddle, which also achieved a 'lift' to the harvested leaf, it was possible to incorporate a small conveyor arranged parallel to the cutting mechanism and sufficiently clear of the plucking table to prevent fouling of the tea bushes. This conveyor fed onto a further conveyor-elevator and the latter provided sufficient lift to enable a leaf container to be accommodated above the general tea bush level. Such was the state of machine development by the end of September. There still remained the question of some form of better selectivity to be investigated but time did not permit worth-while observations

before the bushes developed 'banji' leaf. A device has been made and fitted but cannot now be tested until 1956.

Growth response to this form of harvesting is very much more uniform than hand-plucked bushes. This in itself may provide a much greater degree of selectivity than originally thought possible so that the work devolving on selectivity fitments may not be so exacting as at one time throught necessary.

The rate of harvesting was 30 bushes per minute when traversing between rows and since the development stage is by no means ended there seems no object at present in attempting to increase this rate.

The fundamental information gained to-date gives distinct promise that mechanical harvesting can be made a successful proposition.

From mechanical harvesting of tea to light-pruning is but a logical step and preliminary investigations have been initiated with a "Rotoscythe" machine fitted into the chassis of the same machine as used for plucking. It may be recalled that the "Rotoscythe" consists of an I.C. engine to the crankshaft of which is fitted a rotating blade; thus it revolves at engine speed. As a result of tentative trials it became apparent that the idea could be made to work with however suitable modifications. The chief drawback to the operation being the splitting of some of the pruned branches also to certain objections to a blade revolving at high speeds. It was decided therefore to separate the engine and rotating blade so facilitating speed reduction for the blade which now operates at one-third engine speed. A new blade was made to provide a wider sweep and further trials conducted and although there was a gratifying reduction in damage to the pruned cut it still persisted. This damage results from several causes; the principle one being the impact of the rotating blade over the pruned table which varies with ground irregularities. It will be appreciated that with a ground speed of approximately half-a-mile an hour the cutter rotates several hundred times over the pruned surface before the machine clears the bush. It is this factor which causes the splitting of the tops of the pruned branches. That splitting is not due to the actual cut is confirmed by examination of the

cut prunings. Measures are in hand which it is hoped may considerably reduce if not entirely eliminate the occurrence.

Once the above problem has been solved there seems no reason why it should not be possible to light-prune at the rate of 20 bushes per minute with the machine operating between the rows of bushes.

Continuous Rolling Machines.— Development has been pursued throughout the year. Two prototype machines have been made and operated and a third machine is being made.

The first machine to be made and operated is of tubular formation in which a screw is employed to feed the withered leaf. There have been several drawbacks to the principle used in this machine. Chief of these being the original idea that leaf required rather severe treatment if the desired effect was to be brought about in some seven minutes; this being the time taken for the leaf to emerge from the machine. Persistent changes were made to the internal details aimed at eliminating the dull character of the dry leaf. Towards the close of the season an improvement had been achieved as revealed by a competitive manufacturing test involving (i) Normal two-rolls (ii) One normal roll and C.T.C. (iii) Continuous roller No. 1 (tubular) and (iv) Continuous Roller No. 2. These four tests were conducted with leaf from the same area which was bulked then allocated for the 4 different methods of manufacture.

The average of two competitive tests proved to be as follows:—

	(i) Normal 2 Rolls.	(ii) C. T. C.	(iii) C/Roller No. 1	(iv) C/Roller No. 2
A London Panel of Brokers.	Sh 4/9.7d	Sh4/11 2d	Sh4/10 2d	Sh 4/9
B. Calcutta —do— —do—	Rs. 2/0/11	Rs. 2/9/5	Rs. 1/14/7	Rs. 1/14/7
C. Tocklai Taster.	Rs. 1/15/11	Rs. 2/2/6	Rs. 1/15/2	Rs. 1/15/0

These comparisons are quoted to show that Continuous Roller No. 1 (tubular) is presently producing a much improved product. Continuous Roller No. 2 is but in the initial stages of development and has, subsequently to the above tests, shown an improvement in processing the leaf.

Leaf for machine development was made available up to the end of December.

Continuous Roller No. 3, at present being made, is designed to operate on an entirely different principle to the two existing prototypes. This machine will be ready for trials as soon as leaf is again available in 1956.

A commercial size continuous roller has been made in Calcutta the details of which were based on the knowledge gained with the tubular continuous machine in the earlier period of tests. As a result of a better understanding of treatment of leaf by continuous methods this machine will be suitably altered to agree with later ideas.

During the month of October a technical representative of Messrs. Peabody Ltd., of Vauxhall Bridge Road, London S.W. visited Tocklai at the instance of Mr. Tull. Messrs. Peabody Ltd., are specialists in direct-fired heaters. The occasion was devoted to obtaining information with respect to heat requirements for Tea Dryers as well as for Controlled Withering installations. It is intended that Messrs. Peabody Ltd., will design direct-fired Heaters having automatic temperature control for both Withering and Drying. It is understood that this form of Heater is being used with successful results in the United Kingdom in the Food Industry. These heaters, of course, operate on liquid fuel.

Mr. Tull visited Tocklai during November. The occasion provided a valuable opportunity for a general discussion on development work to-date as well as to assess the potentialities of existing prototype machines.

ASSAM ADVISORY BRANCH: ASSAM VALLEY

P. M. GLOVER, M.B.E., B.SC.—SENIOR ADVISORY OFFICER, ASSAM

DR. P. C. SHARMA, M.SC., PH.D., F.L.S. (LONDON)—ADDITIONAL ADVISORY OFFICER UNDER TRAINING

Touring :— Visits were paid to gardens in the following Circles: —

Assam Valley:

Jorhat	... 12 gardens		Nowgong	... 7 gardens	
Golaghat	... 14 „		Nazira	... 2 „	
Moran	... 6 „		Doom Dooma	... 10 „	
Tingri	... 9 „		Dibrugarh	... 4 „	
Panitola	... 5 „		Nahorkatiya	... 1 „	
Sonari	... 2 „				

North Bank:

Tezpur	... 12 gardens
Bishnath	... 2 „
Mangaldai	... 8 „
Borsola	... 5 „

Cachar:

Lakhipur	... 3 gardens
Chutla Bheel	... 1 „
Hailakandi	... 2 „
Longai	... 4 „

Some gardens were visited on several occasions, some visits were of more than one day's duration.

Meetings.— The Senior Advisory Officer, Assam attended the Annual General Meeting of the Surma Valley Branch Indian Tea Association held in Silchar on 2nd February, 1955; and the Annual General Meeting of the Assam Valley Branch Indian Tea Association held in Tezpur on 20th November, 1955.

Lecture Courses.— For the first time the Annual Lectures Courses were conducted by the Advisory Branch. Three

courses, each of 4 days, were held between 14th February and 5th March.

A total of 81 planters attended. Each course consisted of lectures in the mornings and outdoor demonstrations in the afternoons. Lectures were given by the Senior Advisory Officer, Assam, Senior Advisory Officer, West Bengal, Advisory Officer, Cachar and by the Tocklai Tea Taster. The Biochemist gave a short talk on the principles of controlled withering, and the Resident Engineer demonstrated the Tocklai Withering Tunnel.

Lectures.— The Senior Advisory Officer, Assam gave the following lectures while on tour in the Assam Valley and North Bank:—

"Manufacture"	... Panitola Club	... Panitola Circle.
"Red Rust"	... Misa Club	... Nowgong Circle.
"Red Rust"	... Margherita Club	... Doom Dooma Circle
"Shade"	... Thakurbari Club	... Tezpur Circle
"Manufacture"	... Tingri Club	... Tingri Circle
"Red Spider"	... Paneeri Club	... Mangaldai Circle

The Senior Advisory Officer, Assam lectured on "Seed Nurseries" and "Care and maintenance of Tea Seed Baries" on each of the Vegetative Propogation Courses held between 2nd—12th May, and also demonstrated spraying machinery.

Labour Relations.— The Senior Advisory Officer, Assam served as a member of the expert committee appointed to investigate and recommend on sickling rates in a Labour Dispute on a local garden.

Tea Encyclopaedia.— The following Tea Encyclopaedia Serials were written or revised and republished during the year:

"Organisation of Spraying" Serial 93, was rewritten.

"Proprietary Insecticides Fungicides Selective Weed Killers and Preservatives" Serial 86, was rewritten in co-operation with Pathological and Agricultural Branches.

"Tea Seed Nurseries" a new Serial No. 108 was written in conjunction with Agricultural and Pathological Branches.

Cooper Pegler Pressure Regulating Valve.— Trials with this valve were carried out using the Holder Harriden "All Purpose" Knapsack Sprayer, with an initial charge of air of 40 psi, and a combined air plus liquid charge of 110 psi. The optimum setting for the Cooper Pegler Pressure Regulating Valve was found to be 45 psi. The valve virtually eliminates fluctuation of spraying pressure, there is a fall in pressure of 5 psi only, during 36-39 minutes spraying time, and this occurs only after about 31-34 minutes.

The gain in spraying time from the use of the valve is of the order of 25%. It is considered that the spray pattern produced by the Fan Jet C. 60 using the valve at this setting is satisfactory, and it is believed that jet wear is likely to be considerably reduced, by its use.

The behaviour of this valve over prolonged spraying with spray fluids such as Lime Sulphur, and water dispersible powders in suspension, has not so far been determined.

The Agents are Messrs. McLeod & Co., Ltd., 3, Netaji Subhas Road, Calcutta.

Four Oaks Tractor mounted Sprayer.— As result of trials carried out at Tacklai and at Cinnamara T.E. with a prototype machine produced by Messrs. Four Oaks to the design of the Senior Advisory Officer, Assam, a number of faults was detected and improvements suggested. These improvements have been incorporated in the production models, which have recently arrived in India.

It is estimated that with five men, using the specially designed adjustable spray lance and area spraying technique, it will be possible to cover up to 105' simultaneously on either side of any road or path along which a tractor can travel, at the rate of not less than 1-1½ acres per hour.

The machine is self charging, and can also be used for spraying young tea and shade using the special nozzles provided for these purposes. Detachable booms are provided for low volume spraying of selective weed killers in thatch baries and on grazing land. It can also be used as a Central Charge Pump to fill six Knapsack sprayers simultaneously.

The Agents are Messrs. James Warren & Co., Ltd., 31, Chowringhee Road, Calcutta.

Rim Blight.— A feature of this year has been the widespread occurrence of Rim Blight. This was caused by Green fly often accompanied by Thrips, or by Pink mite often accompanied by Green fly and sometimes also by Thrips. Early pruned tea, when the plucking table was formed early in the season, was not severely affected. Medium pruned tea suffered most severely. Poorly shaded tea always suffered more severely than well shaded tea.

Spraying with DDT 50% water dispersible powder at 1 lb. in 40 gallons proved very satisfactory as a control measure against Green fly and Thrips. Where Pink mite was the causative agent spraying with Lime Sulphur proved satisfactory. Where Pink mite and Thrips or Green fly occurred simultaneously a combined Lime Sulphur/DDT spray was found effective.

Red Rust.— A notable feature this year has been the high incidence of Red Rust on both tea and shade, in most gardens, over a very wide area. The fruiting period has also been abnormal, starting as late as May and continuing well into June, a factor which rendered the usual spray rounds advised (last week of April and 3rd week of May) other than optimum. It is suggested that the time to apply the first round of spray is when fruiting is first observed, between April and May, thereafter a second round should be applied 3 weeks later.

Red Rust attack was observed also, on almost all shade species, Sau (*A. stipulata*) and *A. odoratissima* being particularly affected. It is suggested that young shade planted out in the tea be sprayed with a copper fungicide at the same time, and on

the same rounds, as the tea itself. Prophylactic spraying of shade plants in the nursery twice per month is also indicated.

In those areas where Red Rust is a major problem, Bogamedeloa (*Tephrosia candida*) should either be used as a one year crop only, or its use should be avoided altogether.

Multi-level NPK Experiments.— Three experiments similar to that at Borbhetta, with 34 levels of NPK from $N_0P_0K_0$ to $N_{80}P_{80}K_{80}$ have been laid out on the gardens listed below. There are 34 treatments with two repeats. Levels are as follows:

N_0 P_0 K_0	N_{40} P_0 K_0	N_{80} P_0 K_0	N_{80} P_{40} K_{20}
N_0 P_0 K_{40}	N_{40} P_0 K_{40}	N_{80} P_0 K_{20}	N_{80} P_{40} K_{40}
N_0 P_0 K_{80}	N_{40} P_0 K_{80}	N_{80} P_0 K_{40}	N_{80} P_{40} K_{80}
N_0 P_{40} K_0	N_{40} P_{40} K_0	N_{80} P_0 K_{80}	N_{80} P_{80} K_0
N_0 P_{40} K_{40}	N_{40} P_{40} K_{40}	N_{80} P_{20} K_0	N_{80} P_{80} K_{20}
N_0 P_{40} K_{80}	N_{40} P_{40} K_{80}	N_{80} P_{20} K_{20}	N_{80} P_{80} K_{40}
N_0 P_{80} K_0	N_{40} P_{80} K_0	N_{80} P_{20} K_{40}	N_{80} P_{80} K_{80}
N_0 P_{80} K_{40}	N_{40} P_{80} K_{40}	N_{80} P_{20} K_{80}	
N_0 P_{80} K_{80}	N_{40} P_{80} K_{80}	N_{80} P_{40} K_0	

Panitola T.E.—Panitola Circle Upper Assam in conjunction with the Scientific Officer, Jokai (Assam) Tea Co.

Sockieting T.E.—Golaghat Circle.

Borjuli T.E. —Tezpur Circle, North Bank.

(*a*) *Panitola T.E.* (mature tea).—In the second year of the experiment again *only* nitrogen has shown any significant effect (5% level). 40 lbs. N per acre and 80 lbs. N per acre gave

increases of 3.65 and 6.61 mds. per acre over the no nitrogen plots. The increase of 2.96 mds. per acre from 80 lbs. N per acre as compared with 40 lbs. is also significant at 5% level.

(*b*) *Panitola Young Tea.*—Young tea 4′ × 4′ square one year old from planting.

In the first year of the experiment the effect of treatments was judged by weighing the prunings obtained. Potash only, produced a significant effect (P = 0.05). Both K_{40} and K_{80} produced a significantly greater total weight of prunings than K_0. The difference between total weights K_{40} and K_{80} was not significant.

Leaf weighments will be taken in the coming season.

(*c*) *Sockieting T.E.*—This experiment is laid out in a section of 5′ × 2′ hedge planted tea put out in 1949-50.

In 1955 the first year in which treatments were applied, in so far as yield is concerned the overall effect of nitrogen was highly significant. Both 40 lbs. and 80 lbs. N gave yields significant over no nitrogen (P = 0.01).

The overall effect of phosphate was significant, and 40 lbs. was significantly better than no phosphate (P = 0.01). 40 lbs. phosphate gave a better result than 80 lbs. phosphate (P = 0.05).

The overall effect of potash is significant (P = 0.05) and 80 lbs. potash is significantly better than no potash at this level. The difference between 40 lbs. and 80 lbs. potash was not significant.

The P K reaction was not significant. The N.P.K. reaction was significant (P = 0.05).

The highest yields were obtained from $N_{40}P_{40}K_{40}$ and $N_{40}P_{40}K_{80}$.

No treatment was significant in so far as pruning weights are concerned.

(*d*) *Borjuli T.E. Mature tea.*—On this garden the design differs from that on the other gardens, in that there are 19

levels of NPK: 19 treatments and three repeats. Levels are as follows:

N_0P_0K

$N_{40}P_0K_0$	$N_{80}P_0K_0$
$N_{40}P_0K_{20}$	$N_{80}P_0K_{20}$
$N_{40}P_0K_{40}$	$N_{80}P_0K_{40}$
$N_{40}P_{20}K_0$	$N_{80}P_{20}K_0$
$N_{40}P_{20}K_{20}$	$N_{80}P_{20}K_{20}$
$N_{40}P_{20}K_{40}$	$N_{80}P_{20}K_{40}$
$N_{40}P_{40}K_0$	$N_{80}P_{40}K_0$
$N_{40}P_{40}K_{20}$	$N_{80}P_{40}K_{20}$
$N_{40}P_{40}K_{40}$	$N_{80}P_{40}K_{40}$

Manuring on Bheel soils.—An experiment is being conducted by the Scientific Officer, Jokai (Assam) Co. at Sephinjuribheel T.E. in the Surma Valley.

In 1954 all treatments involving phosphate and potash gave yields significantly greater (P = 0.05) than from the check plots or from plots receiving nitrogen only. $N_0 = P_{80}K_{120}$ gave the highest yield, but the difference between this treatment and $N_{40}P_{40}K_{40}$, $N_0P_{40}K_{80}$ and $N_{40}P_{80}K_{80}$, $N_0P_{80}K_{20}$ was not significant. The yield from $N_0P_{80}K_{120}$ was significantly greater than from $N_0P_{40}K_{40}$ or $N_{40}P_{80}K_{120}$.

Inorganic and Organic Fertilisers.—(*a*) *Halem T.E.*—This experiment is now in its twenty-fourth year.

Treatment are			
Check		No manure	
Cattle manure		200 mds. per acre	(16,000 lbs.)
Inorganic Fertiliser	N.	40 lbs.	per acre.
	P_2O_5	20 lbs.	per acre.
	K_2O	20 lbs.	per acre.

As in 1954 yields from both organic and inorganic fertilisers were significantly better than from the check plots (P = 0.05). The difference in yield between the two treatments was not significant.

(*b*) *Jamirah T.E.*—This experiment is in its eighth year.

Treatments are

Check	...	...	No manure
Oilcake	...	...	80 lbs. N per acre
Sulphate of ammonia	...	...	80 lbs. N per acre

Again in 1955 as in every year 1949 onwards, 80 lbs. N per acre as sulphate of ammonia and 80 lbs. N as oilcake have both given yields significantly greater than from the unmanured plots (P = 0.05). On this light sandy soil there has been no significant difference between the yields from 80 lbs. N as sulphate of ammonia and as oilcake with the single exception of the year 1953, when the return from sulphate of ammonia exceeded that from oilcake.

Shade Nitrogen and Plucking.— This experiment is laid out at Hunwal T.E. and is now in its ninth year. The tea is light leaf Assam.

Treatments are:—Shade and No Shade.

Tipping heights 6″ and 9″

Fertilisers 40 lbs. nitrogen and 80 lbs. nitrogen per acre, in each case with 40 lbs. phosphate and 40 lbs. potash.

In 1955 only the overall effect of nitrogen which was 3.82 mds. was significant (P = 0.05).

In view of the poor condition of the existing *A. stipulata* (Sau) shade, all shade trees were removed during the cold weather 1953-54. They were replaced in each shaded plot by two well grown *A. odoratissima* plants from a nursery. In 1954 there was a residual shade effect of 2.9 mds. significant at the 5% level. In 1955 the residual effect of shade is no longer

significant ; and the young trees have not yet attained a size sufficient to influence yield.

Diseases of Tea Flowers (Sclerotinaceae).— A field trial was laid out at Dhelakhat T. E. in co-operation with the Mycologist, to determine the value of Fernide (Tetremethyl thiram disulphide) in the control of diseases of tea flowers, in an area of Dangri tea seed trees planted in 1950.

Fernide was used as a 0.25% solution with the addition of 2 ozs. of Teepol per 100 gallons as a spreading and wetting agent. Four rounds of spray were applied at 10-12 days interval during the flowering period November-December 1955, using an Universal Major power sprayer in conjunction with a Fordson Tractor.

Plot size was 2.07 acres, 280 tea seed trees ; there are three plots sprayed and three plots control. An estimate of the effect will be arrived at by collection and weighment of seed of the 1956 season.

ASSAM ADVISORY BRANCH—CACHAR

E. D. Heath, B.Sc., Dip. Ag.—Advisory Officer

Touring.— The Advisory Officer paid 118 visits to gardens during the year in the undernoted circles:

Chatla Bheel Circle.
Hailakandi Circle.
Longai Valley Circle.
Happy Valley Circle.
Lakhipur Circle.
North Cachar Circle.

Several gardens requested as many as five visits during the year.

The following visits were paid to Tocklai during the year.

Feb. 10th—March 7th Annual Lecture Courses.
June 25th—June 30th Liaison visit.
Nov. 9th—Nov. 13th Liaison visit.

The Advisory Officer attended the Annual General Meeting of the Cachar Branch Indian Tea Association in Silchar on February 2nd., accompanied by the Director, Tocklai and Senior Advisory Officer, Assam.

The Advisory Officer was on 14 days local leave during October. Touring in the 4th quarter was unfortunately restricted owing to illness.

Lectures.— Lectures and demonstrations were given at the Annual Lecture Courses in Tocklai, but no district lectures were given during the year.

Visits from Tocklai Officers.— January 28th—February 3rd Senior Advisory Officer, Assam, was accompanied on visits to 6 gardens.

April 26th—May 3rd Tea Taster was accompanied to 6 tea factories. Tea Samples from 8 gardens were tasted.

August 2nd—August 12th. The Senior Agriculturist was accompanied on visits to 12 gardens.

October 17th—October 22nd. Senior Advisory Officer, Assam, was accompanied on visits to 6 gardens.

Publications.— The 4th quarter of 1955 saw the first issue of the "Cachar Quarterly", a publication of specific interest to Cachar planters, published by the Advisory Branch.

The first issue included articles on Drainage, Tea Seed Nurseries, Stump Planting of Shade, and the uses of Water Hyacinth.

A survey of the 1954/55 drought was made by the Advisory Branch, as a result of which an article entitled "Drought and Tea" (with special reference to Cachar) has been prepared for publication.

The article gives suggestions for alleviating drought in addition to statistical details of drought effect in tea.

EXPERIMENTS

Manuring.—A replicate of the new Borbhetta NPK experiment was laid out at Roopacherra T.E. in the Hailakandi Circle, in May 1955, and preliminary leaf yields were taken for the rest of the season. This experiment is on a bheel type soil which is known, from chemical analysis, to be low in potash. A small NPK experiment on a bheel garden in the Longai Valley Circle has, for the past 3 years, consistently shown marked response to PK manuring, and no response at all to N manuring. NPK mixtures gave no better results than PK mixtures.

The new experiment is on what might be referred to as "semi-bheel" (*i.e.*, bheel overlaid and admixed with alluvial deposits) and it is thought the results will be more widely applicable, as many of Cachar flats now under tea appear to be of "semi-bheel" type.

Two NPK experiments incorporating some of the treatments used in the above experiment have been laid down, one at Bhubandhar T.E. on pure bheel soil and one at Pathini T.E. on a bheel soil overlaid with some 18″ – 24″ of alluvial deposit.

In addition to these comprehensive experiments a number of trials with Nitrogen/Phosphate/Potash manures have been initiated on various types of bheel soil in the Longai Valley Tea Company.

An experiment comparing the application of N in single (March) and double (March & July) doses has been started at Silcoorie T.E.

Pruning/Skiffing.—Five replications of an experiment involving 4 pruning/skiffing cycles have been laid out on five gardens in different soil/climate regions of Cachar. There are 4 repeats of the experiment on each garden, making 20 repeats of each treatment, and four repeats for the soil/climate region. These experiments are on Larsingah T.E. (Plateau soil); W. Jalinga T.E. (Semi-bheel flat, heavy shade, drought district); Aenakhal T.E. (Semi-bheel flat—drought district, light shade); Burnie Braes T.E. (clay flat—hail belt heavy shade); Borokai T.E. Teela, drought district, no shade).

Termite Control.—An experiment on Control of White Ants was laid down on two Chatla Bheel gardens where white ant damage to live tea bushes, especially young tea, is extremely serious. Results of one trial are noted briefly below. Full details will be found in the report of the Entomological Department.

Number of White Ant Runs counted in each treatment

(Total of 5 replications) Silcoorie T.E.

Treatment Date	A	B	C	D	E	F	G	H	I
5- 7-55	1	0	0	0	0	0	0	0	13
6-10-55	0	0	0	0	0	0	0	0	17
5- 1-55	0	0	0	0	0	0	0	0	62
TOTAL :	1	0	0	0	0	0	0	0	92

Treatments:
A. Aldrin 40% W.P. @ 5 lb./acre.
B. Aldrex 24 @ 4/5th gall./acre.
C. Dieldrin 50% W.P. @ 4 lb./acre.
D. Dieldrex 18 @ 1 gall./acre.
E. Aldrin 5% dust @ 80 lb./acre (with Sulphate of Ammonia).
F. Aldrin 5% dust @ 80 lb./acre (with oil cake).
G. Dieldrin 1% dust @ 400 lb./acre (with Sulphate of Ammonia).
H. Dieldrin 1% dust @ 400 lb./acre (with oil cake).
I. Control.

All treatments are seen to be highly effective. Two other commercial products tried in adjacent tea, *i.e.*, Chlordane and Cowans process, were found to be without obvious effect.

There thus appears to be no need to apply more than 2—4 lbs. of Aldrin or Dieldrin, according to method of application to obtain complete Control of White Ants, at least for 1 year. Observations will continue, to determine the persistency of the treatments.

Red Rust.—Red Rust attack during the year under review was of unusual duration and intensity. Spores were first noted by the Advisory Officer on 30th March at Derby T.E., and were noticed thereafter on every single garden visited until December. Peak sporulation period appeared to be April to July. Many species of shade trees have been observed to become readily infected including all the *Albizzia* species in use, *Derris robusta* and *Adenanthera pavonina*. In nearly all cases however, initial infection can be traced to *T. candida* (Boga Medeloa).

With the apparent extension of the sporing period it is possible for Boga Medeloa less than 1 year old to carry the disease. It has been observed that this green crop, planted in May/June one year, carried Red Rust in the sporulation stage 10 months later, in April the following year. The Advisory Officer does not now recommend Boga Medeloa for tea in Cachar under any circumstances.

Two surgical means of assisting the control of Red Rust were tried at Silcoorie T.E. in young tea. One was the removal of all infected wood in the bush during May; the other was defoliation *below* the pruning level during May to enable spray fluid to reach infected wood. Spraying followed the operation in each case. Efficacy of the treatments cannot be assessed until the peak spore-period in 1956.

Red Spider.— 1955 was reported from many Circles as one of the worst Red Spider years on record. Attack was certainly severe, and sections of tea were seen to be completely defoliated during May.

Field scale trials with Aramite and Akar 338 were conducted at Silcoorie T.E. and compared with results obtained from spraying with standard Lime Sulphur solution. Virtually incessant rain for several weeks after the spraying made accurate observations difficult, but observation indicated that both Aramite and Akar 338 were superior to Lime Sulphur. Further trials are scheduled for 1956.

Stock 203.— 34 Plants raised from Stock 203 seed were planted on an extreme, exposed S.W. teela face with only light shade provided by young (*Albizzia stipulata* and *A. Odora-*

tissima. Adjacent to these on the same slope are 34 plants of Khorijan of the same age. During 1955, leaf from both jats was weighed to the nearest ounce at each plucking round. Final figures were: Stock 203 30 lb. 11 ozs. Khorijan 29 lb. 6 oz. which is an increase of 4.4% for Stock 203 over Khorijan. The trial is of course too small to have any real significance, but it illustrates the possible value of a selected dark leaf jat for adverse environments, where it can outyield one of the best commercial light-leafed jats.

Irrigation and Drought.—A survey of drought damage and after effects was made following the severe drought of the 1954-55 cold weather. The survey covered more than 26,000 acres. As a result of this, and with the co-operation of a large number of garden Managers and Assistants, the Advisory Officer was enabled to prepare a full report of the drought and its effects, together with suggestions and recommendations as to means of alleviating drought damage in future years. A brief extract illustrating the extent of the damage is given below:—

Actual damage reported and directly attributed to drought.—It is necessary now to outline the actual area of tea which this report covers. Of the total estimated acreage in Cachar (71,000 acres), gardens representing 26,051 acres co-operated by submitting invaluable data. On a circle basis, this acreage is divided as follows:—

Longai Valley	... ...	6,619 acres.
Lakhipur	... ...	5,950 ,,
N. Cachar	... ...	4,593 ,,
Hailakandi	... ...	3,674 ,,
Happy Valley	... ...	2,745 ,,
Chatla Bheel	... ...	2,470 ,,
Total:	... ...	26,051 ,,

This is roughly 30% of the total area under tea in Cachar.

From this area, Managers concerned have estimated the number of deaths, due directly to drought, in tea of all ages,

at 2,96,000 bushes. Of these 2,26,000 bushes were under 5 years old, the remaining 70,000 being mature tea (*i.e.*, over 5 years old). The figures for each circle are given below:—

Circle	Deaths in mature tea	Deaths in tea under 5 yrs. old	Total
Chatla Bheel ...	6,500	1,25,500	1,32,000
North Cachar ...	29,000	24,500	53,500
Hailakandi ...	17,500	27,700	45,200
Longai Valley ...	7,500	26,300	33,800
Lakhipur ...	2,500	15,500	18,000
Happy Valley ...	7,000	6,500	13,500
TOTAL: ...	70,000	2,26,000	2,96,000

If the arbitrary figure of 2,500 bushes be taken as equivalent to 1 acre, then the total number of deaths is equivalent to roughly 118 acres of tea, or 0.45% of the total area under consideration.

In addition to the actual deaths, extensive die-back of top growth was reported, affecting mainly skiffed tea, but also to a very large extent pruned tea, especially under 5 years old. The total area reported as being affected was 1,317½ acres, made up as follows:—

Circle	Die-back (Skiffed)	Die-back (Pruned)	Total
Chatla Bheel ...	178½ acres	199¾ acres	378¼ acres
Hailakandi ...	238 „	133½ „	371½ „
Longai Valley ...	173¾ „	78½ „	252¼ „
Lakhipur ...	56 „	81 „	137 „
North Cachar ...	114½ „	51 „	165½ „
Happy Valley ...	13 „	— „	13 „
TOTAL: ...	773¾ „	543¾ „	1317½ „

At the time of writing, (July 1955) the after effects of this die-back were becoming markedly apparent on the majority of gardens, chiefly through the shortfall in crop compared to

the corresponding time in 1954. This shortfall reached figures as high as 1,800 mds. of pucca tea on one 1,000 acre garden.

Granted, the entire shortfall cannot be attributed wholly to drought, as severe Red Spider and Red Rust attacks have also been prominent; but how far have these been assisted by the weakening effects of drought on the tea?"

The only really effective way of combating drought is by irrigation, and this is under consideration by a few gardens in Cachar. By courtesy of Jardine Henderson Ltd., a trial covering 2 acres of mature tea and 2 acres of young tea at Silcoorie T.E. is being conducted using a Wright-Rain irrigation Sprinkler, providing the equivalent of 2" rainfall per month.

WEST BENGAL ADVISORY BRANCH—DOOARS

R. I. MACALPINE—SENIOR ADVISORY OFFICER

Touring.— During the year the "circuit" system of touring, whereby a block of dates is allotted to each Sub District, was continued and all Sub Districts were visited.

In addition to these regular tours, individual estates were visited "on call" for particular reasons, including a special visit to a group of estates in the Darjeeling District in connection with manuring policy.

In all, visits were paid to estates in the Dooars on 110 occasions and on 4 in Darjeeling.

In the course of touring, lectures were given to Assistant Managers on four occasions.

The Advisory Officer visited Tocklai on two occasions, and in February—March took part in the Annual General Courses.

He attended the Annual General Meetings of the Darjeeling Branch Indian Tea Association, Dooars Branch Indian Tea Association, Terai Planters Association, and Indian Tea Planters Association.

EXPERIMENTS

(i) Field Trials.

The N P K trial initiated in 1954 at Kalchini was continued during the year. Analysis of the 1954 yield data indicate that in the first year of treatments significant effect at the 5% point was produced by N × K interaction only.

Main effects of either P or K, or the effects of their interactions have not shown any significant results at the 5% point though there is a tendency for the overall effect of K to approach significance. It is interesting to note that in the presence of 80 lbs. N, 20 lbs. K and 80 lbs. K are showing statistically better results than absence of K and further that 20 lbs. K has produced the highest yield of all.

Nitrogen has not shown significant effects because of the low degree of freedom available for error for testing significance of N, but it should be noted in this connection that the primary object of this experiments is not concerned with the effect of N but of P & K and their combinations with and without N.

(ii) Pruning cycle experiments

Baradighi Tea Estate and Chuapara Tea Estate.—These experiments were designed to test the effect of annual and biennial pruning cycles. In the unpruned year, three levels of skiffing have been included. In addition, provision has been made to include a series of plots which will be medium skiffed when the light, medium and deep skiffed plots of the biennial cycle series are pruned. This has been done to counteract effects of variations in climatic conditions from year to year.

During the 1955 season yield data was recorded for assessment of initial comparability.

(iii) Times of pruning experiments

Central Dooars Tea Estate.—This experiment has been designed to compare yields of tea pruned or skiffed at different times during the dry season.

Treatments will be accorded in mid November, mid December, mid January, and mid February respectively.

The experiment has been initiated as considerable diversity of opinion has occurred over the results of early pruning under the climatic conditions which prevail in the Dooars, and in particular in relation to spring droughts.

During 1955 initial yields were recorded.

At the end of the year a further similar experiment was being laid out at Chuapara Tea Estate.

Observation Plots and miscellaneous trials at Nagrakata Headquarters.--

(*i*) *Seed Storage vis a vis Twisted Root.*--Plants raised in nurseries from seed subjected to different packing treat-

ments and stores for varying periods were examined for twisted root development.

Results are as follows:—

Bed No.	Treatment.	Date of sowing.	Untwisted	Twisted.	% Twisted.	Remarks.
1.	Control ...	2-12-54	269	15	9%	2 completely twisted.
2.	Wet Charcoal	15-12-54	117	27	15%	3 -do-
3.	Tillex* ...	-do-	168	23	12%	3 -do-
4.	Untreated ...	-do-	109	14	13%	5 -do-
5.	Wet Charcoal	15- 1-55	219	11	5%	4 -do-
6.	Tillex ...	-do-	119	27	22%	17 -do-
7.	Untreated ...	-do-	122	27	22%	15 -do-
8.	Wet Charcoal	15- 2-55	60	6	10%	6 -do-
9.	Tillex ...	-do-	only one survival.	...	...	1 -do-
10.	Untreated ...	-do-	109	51	47%	7 -do-
11.	Wet Charcoal	13-3-55	121	31	26%	5 -do-
12.	Tillex ...	-do-	No germination			
13.	Untreated ...	-do-	101	55	55%	5 -do-

*Tillex is the proprietary name of a mercurical fungicide prepared as a dry seed dressing.

It should be noted that the category " twisted " includes all seedlings exhibiting a more or less right angled bend at the cotyledon area, and not only where one or more complete convolutions had occurred. The number of seedlings exhibiting this feature are noted separately in the " Remarks " column. It will be noted that while the trend is toward an increase in the number of twisted roots as the storage period lengthens, under packing treatments, wet charcoal packing, (*i.e.*, 5% moisture content by weight) is considerably better than untreated or Tillex treated seed. Unfortunately the trial was vitiated to a considerable

extent by heavy casualties occurring during the drought owing to the failure of water supplies at Nagrakata for adequate watering of nurseries, but trends are evident.

(ii) Green Crops

(*a*) *Stylosanthes gracillis*.—This species has been extended vegetatively by cuttings in various areas of the Headquarters compound to study its behaviour under various conditions. From observations made during the past years the following points are of interest in relation to its possible employment as a ground cover crop in tea.

(1) Under anything approaching dense shade it tends to straggle and push up into the overhead cover. Under very dense shade it remains suppressed.

(2) It grows luxuriantly in the open and under such circumstances forms a dense mat of vegetation over the ground at a *height of up to 2 or 3 feet*. It can stand heavy and continuous sickling during the growing season, recovery being very rapid.

Under light shade it tends to push up into the cover crop in its immediate vicinity but where the ground is exposed to direct light it remains a scandent shrub. Its growth habit of arising from a central root stock makes it easy to sickle or clear away from ground which is to be cultivated.

(3) It remains green long after indigenous species such as Thatch (*Imperata arundinacea*) or Bagrakote jungle (*Borreria hispida*) have dried out during the cold weather. Even after sickling in December regrowth has occurred, and the species appears thus to be much more xerophytic in habit than others in the locality.

In this connection it should be noted that during the severe drought of February—May it remained comparatively green throughout and the soil under the mat of vegetation did not appear to dry out and crack as in the case of adjoining areas under Thatch and Bagrakote jungle. It would appear that the mulching effect of the cover afforded to the soil by its presence and the heavy litter of fallen leaves under it, counterbalances to

some extent the reduction in moisture content of the soil that must occur through transpiration.

In the light of the above it is considered that it is not likely to be suitable for introduction as a cover crop in mature tea but that it might be of value as a green crop in advance of planting out of tea, and that under light shade from overhead cover crops such as *Crotalaria anagyroides* of *Tephrosia candida* it could be retained on the ground during the early years of establishment of a plantation.

(*b*) *Mimosa invisum.*—This species reported on in the previous year's Annual Report was also extended to other areas. Profuse natural regeneration arises from seed of the previous year and in the open it forms a highly weed suppressive mat of vegetation. It climbs rapidly into any overhead crop, which except in the case of stout stemmed species is overwhelmed by the weight of the *Mimosa*.

The species is thus not likely to be suitable for introduction into mature tea, but its weed suppressing powers make it a possibility for pre-preparation of ground. The ease with which it reproduces itself from seed and the luxuriance of its growth may make it however difficult to eradicate should necessity arise.

(*c*) *Calapogonium mucunoides.*—A small quantity of seed of this species was obtained from Tocklai for trial and was sown in roughly prepared drills in a thatch and weed infested area. Only two rounds of weeding immediately after germination were required to establish the crop which rapidly invested the area completely suppressing the Thatch, Bagrakote jungle and other weeds in the locality.

As it is a strong climber it would be unsuitable for introduction into tea but would be suitable for pre-preparation of ground.

(*d*) *Crotalaria agatiflora.*—A small quantity of seed of the above was obtained from South India. Germination was poor. The few survivals were severely attacked by insects throughout the growing season and plants made little or no growth until well into September.

(*e*) *Seshania cinerescens*.—A small quantity of seed again obtained from South India, was put down for observations on rate of growth and growth habits.

Growth is fast but the growth form of this species in nursery beds is rather like that of Jute, stems being spindly and etiolated, the foliage density being somewhat low.

(*f*) *Crotalaria lanata*.—This species failed completely at Nagrakata.

(*iii*) *Shade Trees.*

(*a*) *Species*.—Seed of the following species was put down in nurseries during the year.

(1) *Acacia lenticularis* (from the Terai)

(2) *Albizzia richardiana* (from South India)

(3) *Pterocarpus marsupium* (from South India)

(4) *Pterocarpus dalbergioides* (from Andamans)

(5) *Derris robusta* (locally)

Acacia lenticularis and *Albizzia richardiana* have been extremely satisfactory both in respect of germination and rate of growth and have far outstripped that of *A. odoratissima*, and *A. stipulata* grown in the same area.

Plants of the former two species will be distributed to Estates for trial in the field.

Germination of both the Pterocarpus species was poor and growth and survival rate low but it should be noted seed was received late and not put down until July.

(*b*) *Root cuttings*.—As a preliminary trial a small quantity of cuttings of roots of *Albizzia odoratissima, Derris robusta* and *A. stipulata* were put down in nursery beds in May—June. The roots were obtained from mature trees which had been uprooted and were in sections of approximately 9″ in length and from finger to thumb thickness, and were dibbled into a depth of 8″.

A. stipulata failed entirely to reproduce but in the case of the other two species 75% success was obtained. While the rate of growth of *A. odoratissima* thus raised is relatively slow, and the height of plants at the end of November was somewhat lower than those of seedling plants raised in an adjoining nursery, that of Derris robusta was considerably in excess of seedling plants.

Plants were dug up to examine root systems. In both species there was a tendency for root development to be superficial, though in a number of plants there was evidence that some of the laterals were starting to turn downwards.

4. Green Crops in Estates.—

(*a*) *Priotropis cytisoides.*—The employment of *Priotropis cytisoides* as an alternative to *Crotalaria anagyroides* and *Tephrosia candida* is gaining ground in a number of localities. Once established it grows rapidly and produces a stout stemmed shrub of a height of from 8′ - 10′. It does tend on occasions to develop horizontal laterals which when trimmed in the course of cultural operations makes the plant top heavy and thus liable to wind damage. Pollarding to a height of 3′ - 4′ from ground level during January--February in order to reduce the length of brittle bole, materially reduces this disadvantage.

On ocular estimate the species appears to be a satisfactory alternative to Crotalaria and Tephrosia for mature tea, young tea, and for green crop shading of tea nurseries. The plant retains its leaves during the dry season to a much greater degree than both the other species mentioned and produces therefore more shade. This factor should be taken into consideration in respect of ultimate spacing for tea nurseries.

(*b*) *Desmodium gyroides.*—A limited number of estates have obtained small quantities of seed of this species which occurs naturally mainly in the foothill areas of West Bengal. The species is particularly notable for the heavy foliage it carries and appears to be a suitable alternative green crop. It is unfortunately liable to infestation by gall forming eel worms and it should not therefore be employed in areas likely to be used for tea nurseries in the meantime.

5. Pathological.—

(*a*) *Metatetranychus bioculatus* (Red Spider).—The early part of the season of the year under review was notable for an epidemic of this pest. Incidence was wide-spread and appeared in a severe form in localities which are usually considered relatively free from the pest.

Unpruned and pruned, shaded and unshaded tea, defoliated or non-defoliated tea appeared to be equally affected once the epidemic had taken hold. The extent to which tea became affected and the rapidity with which spread occurred made it virtually impossible to spray at the required intervals, and little control could be effected.

It is reasonable to presume that the droughty conditions which prevailed during the year was responsible in no small measure for the epidemic nature of the attack but it is worthy of note that attention was drawn in last year's Annual Report to the recrudescence of Red Spider at the end of the season. This has again occurred this year, Red Spider having again become very evident both in tea nurseries and in mature tea as early as October.

Prophylactic measures for control as recommended in Tea Encyclopaedia Serial 71/1 filed under J 3 which provide for spraying comparatively early in the off season would appear to be an essential under the climatic conditions which now prevail in the Dooars.

A corollary to severe Red Spider attack has been the damage to faliage caused by *Colletotrichum Camelliae* (Brown Blight) which rapidly followed upon that caused by the former. In a number of localities as a result of the combined attacks of Red Spider and Brown Blight, foliage immediately below the plucking table became thin and meagre, and bushes lacked vigour.

(*b*) *Biston suppressaria* (Looper Caterpillar). A severe epidemic of Looper occurred in certain estates in the Eastern Dooars this year and had repercussions in that new foliage regrowth was destroyed. This in combination with Red Spider

attack must be held to be responsible for the actual death of certain bushes, the vigour of which was apparently not sufficiently high to allow of production of fresh foliage regrowth.

(*c*) *Pests of Shade*.—Pysillids continued to do damage to nurseries of *A. odoratissima*. Where spraying was regularly done at short intervals from the early stages, control has been in the main effective. Certain estates report success from the employment of Dieldrin. Elsewhere B. H. C. preparations (e.*g.*, Gammexane) have continued to prove effective.

Larvae of *Rhesala moestalis* continued to be a major pest of shade tree nurseries and young plants in the field. Spraying alone has not proved entirely effective as the habit of the caterpillar of webbing itself up in the foliage prevents to a great extent the chemical coming into contact with the insect. In nurseries destruction by hand in addition to spraying has effected reasonable control.

In a number of shade tree nurseries particularly in the Eastern Dooars, young seedlings of all species, including *Albizzia moluccana*, have been attacked by *Agrilus beesonii*, plants being attacked at the collar region as soon as stems become at all woody.

Trees in the field at the sapling stage have also been heavily attacked in certain localities, again mainly in the Eastern Dooars, by this pest.

At Sam Sing Tea Estate a comparatively large number of *A. odoratissima* and *A. stipulata* mature trees were subjected to attacks by a Longicorn beetle, identified as *Xystrocera festiva*. The larvae appear at first to confine their attention to the outer tissues, only boring into the wood at a later stage. In the early stages they live in colonies and the extent of damage to tissue in localised patches is considerable. Attacks can occur on branches or on the main stem, which in some cases were attacked even at ground level.

(*d*) *Cephaleuros parasiticus* (Red Rust).—This algal parasite was again widespread this year and was prevalent on both mature

and young shade trees of *A. stipulata* and *A. odoratissima* in the field and in the nursery.

Tephrosia candida was as usual heavily infected. No Red Rust has hitherto been observed on *Priotropis cytisoides* but there have been reports of its presence in certain localities on *Crotalaria anagyroides*.

(*e*) *Root diseases*.—Primary Root diseases, the most common of which are *Fomes lamaoensis* and *Ustilina zonata*, continue to be prevalent in all localities in the Dooars.

The dangers arising from failure to deal timely with these diseases is, it is felt, being more widely appreciated within recent years, and a number of estates are actively engaged in concentrated eradication programmes.

WEST BENGAL ADVISORY BRANCH—DARJEELING AND TERAI

A. D. SWAN, B.SC., *Advisory Officer, Darjeeling*

Staff.— The Advisory Officer returned to Darjeeling from leave in the U.K. in July, 1955.

Touring.— Twenty-three visits were made to gardens in the Darjeeling District and four to gardens in the Terai.

A liaison visit to Tocklai was made between 21st and 30th November.

Meetings.— The Advisory Officer attended the following Sub-District meetings.

Rungbong Valley Sub-District	. .	27th July
Darjeeling West Sub-District	...	24th August
Sonada Sub-District ...	...	22nd September

Visits.— Mr. Farwardin from the Government of Iran tea department visited Darjeeling from 14th—25th July and visited several gardens accompanied by the Advisory Officer. Mr. S. K. Dutta, Senior Agriculturist visited Darjeeling from 14th—22nd December.

Experiments.

Bush Selection.—A further ten bushes were selected in Puttabong Tea Estate and submitted to miniature manufacture. Twenty-two bushes previously selected and manufactured last year were again included in this programme.

It was originally hoped that it might be possible to find visual features of the bush which would be indicative of Darjeeling Flavour in that bush. However maniature manufacture has to be arranged with a neighbouring garden which has resulted in the standard of manufacture being lower than desired. This has led to tasting difficulties and conflicting reports in that respect. It has therefore been impossible to draw definite conclusions. There is however some indication that those bushes showing the most marked petiole pigmentation are those which are most frequently reported to have "some flavour".

Maharanee N.P.K. Experiment.—The results of this experiment from 1940 were summarised during the year.

The experiment was laid out in 1940 and consists of 32 plots of 200 bushes each. There are eight treatments repeated four times. In 1952 the treatments were changed. Treatments were as follows:

	1940—1951			1952—1955		
	N.	P.	K.	N.	P.	K.
1. No manure						
2. N. only	60	—	—	60	—	—
3. P. only	—	30	—	1 120		—
4. K. only	—	—	30	—	—	120
5. N.P.	60	30	—	60	120	—
6. N.K.	60	—	30	60	—	120
7. P.K.	—	30	30	—	120	120
8. N.P.K.	60	30	30	60	120	120

In 1948 4 plots receiving 120 lbs. N were added.

The actual annual yields in maunds/acre were as follows:

Year	Control	N	P	K	NP	NK	P.K.	N.P.K.	N_{120}
1940	1.018	1.123	1.043	0.980	1.254	1.765	0.988	1.715	
1941	2.505	3.549	2.414	2.524	4.045	5.134	2.505	4.874	
1942	0.382	0.870	0.403	0.406	0.801	1.078	0.378	1.204	
1943	2.148	4.599	3.478	3.398	2.394	4.905	2.405	4.436	
1944	2.586	5.100	2.588	2.525	5.301	6.325	2.780	6.723	
1945	2.506	4.952	2.837	2.261	5.324	6.188	2.838	6.939	
1946	0.557	1.372	0.662	0.686	1.461	1.984	0.600	1.955	
1947	2.320	4.370	2.120	2.340	4.076	5.430	2.250	4.880	
1948	3.633	7.793	3.660	3.946	8.295	8.168	3.427	9.667	10.21
1949	1.420	3.040	2.980	1.400	3.120	1.630	1.470	3.800	4.34
1950	2.350	3.530	3.620	2.350	3.780	2.500	2.700	4.190	5.35
1951	0.466	0.650	0.670	0.550	0.660	0.610	0.540	0.420	1.08
1952	3.816	4.690	5.270	4.060	5.140	4.190	3.970	6.500	6.87
1953	1.900	2.800	2.790	2.150	3.000	2.230	2.290	3.020	6.44
1954	0.746	1.490	1.970	1.000	1.620	0.780	0.860	2.270	2.80
1955	3.960	5.470	5.300	4.320	4.810	4.020	3.810	5.740	7.74
Total	32.313	55.398	41.805	35.896	55.081	56.917	33.811	68.333	44.83
Average	2.019	3.462	2.613	2.243	3.444	3.557	2.113	4.271	5.60

In the year 1951 no manures were applied due to non-availability.

The following are the averages of the yields from 1940-1950 and 1952-55.

	Control	N	P	K	NP	NK	PK	NPK	N120
1940-50	1·948	3.663	2.346	2.072	3.623	4.101	2.031	4.580	6.63
1952-55	2.405	3.612	3.832	2.882	3.642	2.805	1.757	4.382	5.66

Throughout the experiment N alone gave significantly higher yields at the 5% level especially in the year 1948.

N.K. interaction showed significant results in 1940, 1941, 1942 and in 1952 but in all other years failed to reach significance.

N.P. interaction was significant only in 1948, and P alone was significant only in the year 1951.

P.K. interaction was not significant in any year.

K alone gave significant results only in the years 1951 and 1952.

This experiment is still being continued and it is intended that a comprehensive analysis will be carried out later.

N.P.K. Experiment Rangneet.—This experiment was laid out in 1952 and consists of 34 treatments in a split plot layout. Treatments consist of applications of N.P. & K. in varying proportions.

Initial yields were recorded throughout 1954. Manures were applied in March 1955 and the first experimental yields recorded during the year.

In 1955 no significant effect was produced by any treatment.

Times of Pruning—Puttabong.—This experiment mentioned in previous reports, continues but has not yet continued throughout one complete pruning cycle.

Green Crops.—

Stylosanthes gracilis :—Throughout the year several estates in the District have made attempts to establish this crop with varying degrees of success. Cases have however been noted of complete die-back in the cold weather, even at medium elevations. This has been noted to occur suddenly in what was hitherto an apparently healthy crop.

Priotropis cytisoids :—More use of this crop has been made by gardens during the year and in most places appears to be satisfactory. Seed obtained from the crop at Puttabong was

distributed to several gardens. Even at fairly high elevations (5,500′ approx.) it grows fairly quickly and produces luxuriant growth.

It has been found to react satisfactorily to lopping and pollarding. Stands of this crop have now been in the ground for three years and no signs of disease have been detected.

Desmodium gyroides:—This crop has now been tried for three years and has not been found satisfactory at high elevations. Growth is extremely slow and little succulent foliage is produced.

General.— During the year steps were taken to enable a survey to be made in the district, of the various kinds of tea, and acreages in different elevational ranges. It is hoped that all gardens will co-operate in this survey.

Several gardens made available their daily rainfall and temperature figures for as many years as the records were available and copies of these data were made.

Attempts have been made to find a suitable site to lay out a meteorological station, and to find suitable sites to lay out proposed new experiments. A suitably exposed meteorological site has not yet been found.

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